#196

REVCO SCIENTIFIC, INC

275 Aiken Road

Asheville, NC 28804

SERVICE DATA MANUAL

CUSTOMER: Defense Personnel Support Center
Address: 2800 South 20th Street
Philadelphia, PA 19148

CONTRACT NUMBER: DLA120-90-C-8538

Equipment Description:
HARRIS CHEST FREEZER BY REVCO SCIENTIFIC, INC.
NSN 4110-01-320-1699

MODEL MBF-500
Redundant Refrigeration System

Serial Number:_____

March 27, 1990
Rev. 10/11/90
A89802H01

SECTION 100.

TABLE OF CONTENTS

TABLE OF CONTENTS

SECTION I MECHANICAL/ELECTRICAL

Subsection	Subject	Page
	COVER SHEET	
100	TABLE OF CONTENTS	i
	TABLE OF FIGURES	iv
200	RECEIVING AND UNCRATING	
	RECEIVING PROCEDURE	1
	TRANSPORTING	3
		4
300	INSTALLATION AND OPERATION	
	GENERAL DESCRIPTION & OPERATION	5
	ACCESSORIES DESCRIPTION	7
	I. INVENTORY RACKS (OPTIONAL, NOT IN CONTRACT)	11
	II. REMOTE ALARM	11
	III. CHART RECORDER	11
	IV. CO_2/LN_2 BACKUP SYSTEM	13
	V. VOLTAGE SAFEGUARD	14
		20
	SEQUENCE OF OPERATION	21
	I. INSTALLATION CHECK LIST	21
	II. LOADING FREEZER	23
	III. CARE & PERIODIC MAINTENANCE	27
	IV. DRAIN CONNECTION	27
400	REFRIGERATION SYSTEM	29
	THEORY OF OPERATION	31
500	DRAWINGS	
	REFRIGERATION FLOW	33
	CABINET WIRING DIAGRAM	35
	CONTROL WIRING DIAGRAM	37
	CABINET OUTLINE DRAWING	38
		39
600	CASCADE REFRIGERATION	41
	NOMENCLATURE	43
	REFRIGERANTS	45
	SAFETY	48
700	MAINTENANCE & SERVICE	51
	TOOLS	53
	TROUBLESHOOTING GUIDE	54
	PROCEDURES	57
	OPERATING DATA SYSTEM A	65
	OPERATING DATA SYSTEM B	67
800	SERVICE PARTS	69

SECTION II ELECTRONICS 77
CONTROL CALIBRATION 79
THEORY OF OPERATION 81
TROUBLESHOOTING GUIDE 88
COMPONENT PARTS LIST 93

APPENDIX A 99

TABLE OF FIGURES

Fig. #	Description	Page#
1	General freezer outline drawing	7
2	Control panel detail	9
3	Accessory storage rack	11
4	Accessory remote alarm, panel view	12
5	Accessory remote alarm, wiring diagram	12
6	Recorder detail	13
7	CO_2 Backup system	19
8	Voltage Safeguard, front panel	20
9	Voltage Safeguard, connections	20
10	Control panel detail	22
11	Holding box domensions while freezing	24
12	Compressor mounting detail	26
13	Redundant cascade system diagram	31
B23625	System flow diagram	35
14	Cabinet wiring diagram	37
15	Control wiring diagram	38
16	Cabinet outline drawing	39
17	Refrigerant saturation curve	46
18	Electrical junction box layout	73
19	Refrigeration deck layout	75
20	" " "	76
21	System block diagram	85
22	Power block diagram	86
23	Block diagram	87
24	Component layout	91
25	Schematic Diagram	97
26	CO_2/LN_2 Control System Layout & Parts	102

SECTION 200.

RECEIVING & UNCRATING

RECEIVING PROCEDURE

Export packaging is identified by:

- Completely enclosed with plywood or chipboard.
- Unit mounted on skids.

Tools necessary:

1. Hammer
2. Small pinch bar
3. Screw Gun (compressed air or battery powered)

STOP!! DO NOT TIP UNIT OVER OR STAND ON END. CALL THE FACTORY FIRST FOR SPECIFIC INSTRUCTIONS IF UNIT ABSOLUTELY MUST BE TIPPED ON END.
1-800-438-4851

There are two Tiltwatch Labels affixed to the end of the freezer packaging. The center of these labels has a small round window which turns bright red to signal mishandling of the product.

1. When shipment is received note the color of the indicators.

2. If either label has been activated, note on the delivery receipt which packages show a red label and request the carrier's driver to sign the receipt acknowledging that the label was activated.

3. Before turning over the receipt to the driver, uncrate the unit and, if there is internal damage, please note the fact on the delivery receipt. At this time you may refuse the shipment.

4. Uncrate by removing the wood screws which hold all panels in place.

OPENING CRATE FOR IN STORAGE SERVICING

The front panel is the only one removed for in-storage servicing. The wood screws that hold the front panel in place may in time, become enlarged. In this case new ones may be drilled 1" on either side of the original ones. Use a 7/64" or a #37 twist drill. A #6 x 3" screw for two thicknesses of 1 x 4 lumber and #6 x 1½ screw for one thickness.

5. The shipment will be removed by the carrier and returned to the warehouse. It is recommended at this point that you call the manufacturer and advise of the condition of the shipment. (800/438-4851)

After the protective packaging has been removed from the freezer it will be left standing on the shipping base with foam pads between the freezer and the shipping base. To remove the freezer from the base use a fork truck. Slide the forks into the holes provided in the front of the freezer. Raise it high enough to remove both the foam pads and the freezer from the shipping base.

USE CAUTION AND DO NOT ALLOW THE FREEZER TO DROP EVEN A FEW INCHES AS SERIOUS DAMAGE CAN RESULT.

TRANSPORTING PROCEDURE

If it is necessary to transport a freezer in your vehicle after uncrating be sure to leave the shipping skids in place at the time of uncrating. It is much easier to handle the equipment and damage is less likely to occur if the skids are in place.

HANDLE WITH CARE

SECTION 300.

INSTALLATION & OPERATION

GENERAL DESCRIPTION & OPERATION

MBF500 Low Profile Redundant Refrigeration Freezer

This unit is a low temperature freezer designed to operate with a chamber temperature in the range of -65 to -85 ^{0}C. (-85 to -121 ^{0}F.)

The cabinet configuration is that of a rectangular solid measuring 111" long (281.9cm) x 53.75" high (136.5cm) with lid and all covers in place x 38.32" deep, including lid handle and hinges (97.3cm). When installing the freezer, a minimum of six inches (6") must be provided on all sides of the freezer for proper air circulation.

Weight is 1600 lbs.(727.3Kg) net.
Shipping weight is 1880 lbs (854.5Kg).

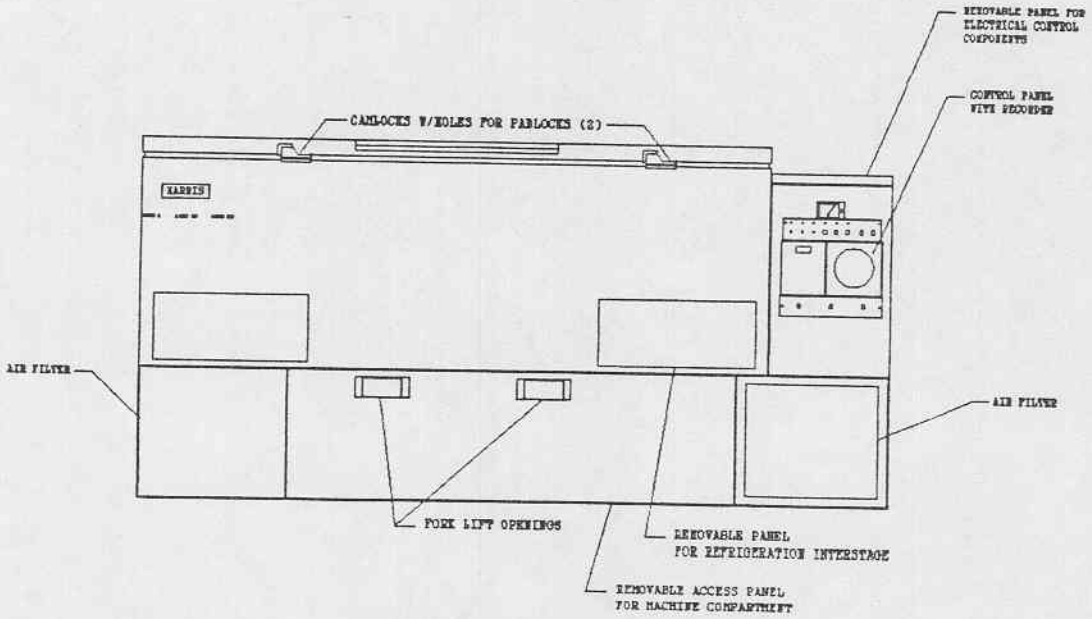

REMOVABLE PANEL FOR ELECTRICAL CONTROL COMPONENTS
CONTROL PANEL WITH RECORDER
CAM-LOCKS W/HOLES FOR PADLOCKS (2)
AIR FILTER
AIR FILTER
FORK LIFT OPENINGS
REMOVABLE PANEL FOR REFRIGERATION INTERSTAGE
REMOVABLE ACCESS PANEL FOR MACHINE COMPARTMENT

Figure 1...General freezer outline drawing

See Figure 2 for control panel details

The interior useable space is also rectangular. The four corners are coved. With insulating sub lids in place it measures 83" long (210.8cm) x 24.375" high (61.9cm) x 22.63" deep (57.5cm). The interior volume is 26.5 Ft^{3}. (750.3 liters.)

The cabinet is insulated with nominal 5" of foamed-in-place polyurethane insulation.

CAUTION

DO NOT DISCARD THE SUB LIDS. THEY ARE NECESSARY FOR THE PROPER OPERATION OF THE FREEZER.

The refrigeration arrangement employed in this freezer is a specially designed assembly using four semi-hermetic motor compressors. This design is termed a "redundant cascade system". There is a more complete description of this in the pages following. Stainless steel storage racks for inventory control are available as an option and must be ordered separately.

GENERAL CONSTRUCTION DETAILS

The lid is held tightly closed by means of cam locks having provision for a user supplied padlock.

Durable corrosion protection is provided by an electrostatically applied epoxy fused powder coating over cold rolled steel.

To provide a redundant refrigeration system, the inner tank is double wrapped with copper tubing forming a dual circuit evaporator. In addition, each of these circuits has its own compressor, condenser and liquid refrigerant control (capillary tube). Each of the redundant systems of this freezer will support full operation to maintain the storage temperature. When set to alternate between system "A" and system "B", refrigeration is applied to the freezer chamber alternating between systems on each cycle.

CONTROL PANEL

(See Figure 2)

All controls are located at the right end of the cabinet.The labelled illustration on the next page shows the panel top section with status indicator lights, control adjusting screws and system push buttons. Directly below the control panel at the left is the Digital Display window. The chart recorder is on the right.

Note: To set the adjusting screws, use a flat blade screwdriver with a 1/8"wide by approximately 3½" long blade.

Pressing the scan button (item #7) repeatedly will sequentially light the red, green and amber status LED's. When the LED above the desired function is illuminated, turning the adjusting screw will change the digital display indicating a change in the setting being made. When the green cabinet temperature LED is on, the display will be indicating actual cabinet temperature.

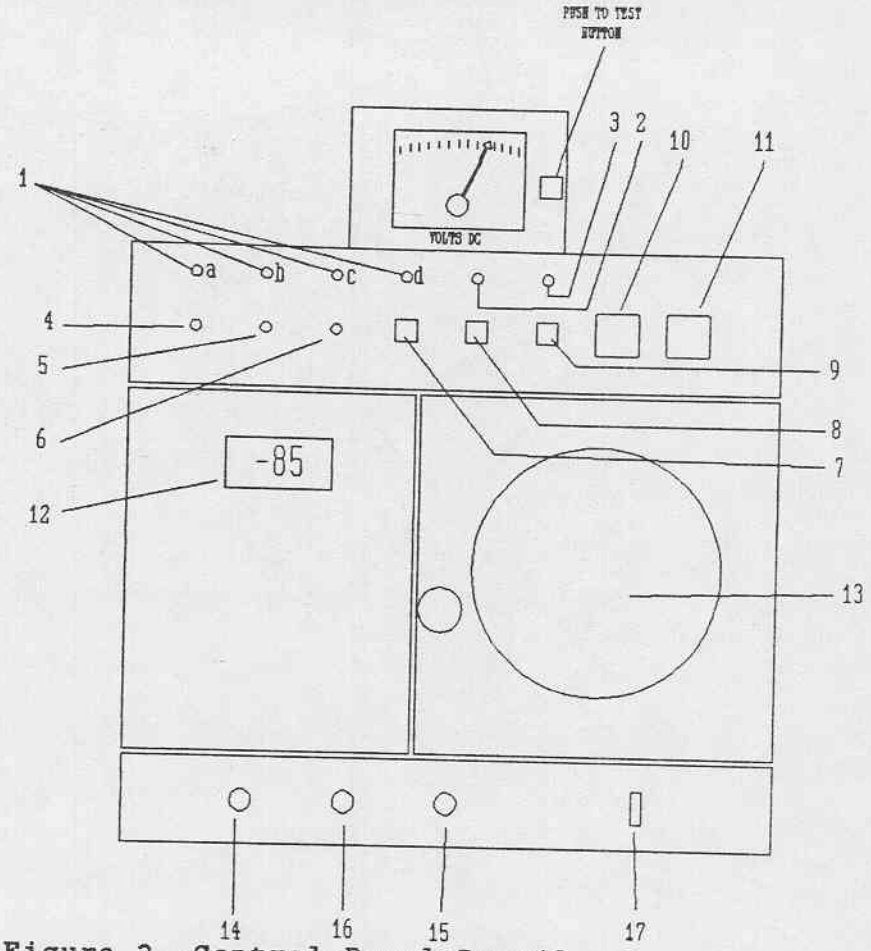


Figure 2..Control Panel Detail

1. Indicator LED's for display modes.
   a. Cabinet temperature setpoint (amber)
   b. Cold alarm setpoint (amber)
   c. Warm alarm setpoint (amber)
   d. Cabinet temperature (green)
2. Temperature failure LED (red)
   "ON" when cabinet temperature has exceeded set alarm points.
3. Power failure LED (red)
   "ON" when AC power is not available at the freezer.

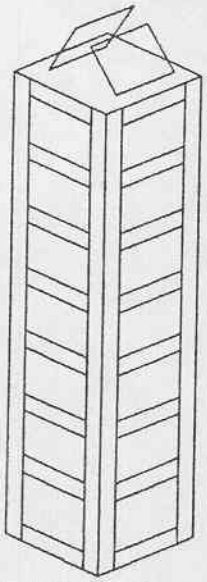
   NOTE: A flat blade screwdriver with a 1/8" wide x approx. 3½" long will be required to adjust setpoints at items 4,5, & 6.

4. Cabinet temperature setpoint adjusting screw. Sets control set point.
5. Cold alarm setpoint adjusting screw. Sets cold alarm point.
6. Warm alarm setpoint adjusting screw. Sets warm alarm set point.
7. Scan button. Sets parameter diplayed in digital display.
8. Audio silence button. Temporarily silences local audio for 5-7min.
9. Alarm test button. Provides test of warm alarm point.
10. Key-operated alarm ON/OFF switch. Turns on local audio alarm.
11. Key-operated compressor ON/OFF switch. Turns on power to compressors and control system.
12. Digital temperature indicator.
13. Temperature recorder, 7-day, 6" diameter.
14. System "B" indicator light. "ON" when system "B" 2nd stage running.

15. System "A" indicator light. "ON" when system "A" 2nd stage running.
16. Alternate system alarm indicator light.
    "ON" when auxiliary control is causing both systems to operate.
17. Heater switch. Operates breaker strip condensate heater.

ACCESSORIES DESCRIPTION

I. STORAGE RACKS (Accessory #4028) (See Figure 3)



These optional stainless steel accessory storage racks, ordered separately, are useful for inventory control. The illustration at left shows the typical rack. It has folding handles at the top for easy removal from the freezer cabinet and a vertical retaining rod to keep the boxes in place. Each rack holds 16 boxes. A full set for the freezer would require forty (40) #4028 racks.

CAUTION: THESE RACKS WILL BE EXTREMELY COLD, AS ARE ALL INTERIOR SURFACES OF AN OPERATING ULTRA LOW TEMPERATURE FREEZER. DO NOT ALLOW BARE SKIN CONTACT WITH ANY OF THESE SURFACES. WEAR INSULATED GLOVES WHEN WORKING INSIDE THE FREEZER.

Figure 3
Accessory storage rack

II. REMOTE ALARM PACKAGE (Accessory #5612)
(See Figure 4 and Figure 5)

The remote alarm package was developed to provide an alert to power outage or the cabinet temperature having exceeded its preset limits, either high or low. The cabinet is designed to mount to the wall using two pan head #10 screws in the keyhole slots in the back. There is a factory installed power cord with 3 prong grounded plug for 100-120VAC/10/50-60Hz power supply. Power requirements will not exceed 60 watts. There are two terminal strips on the bottom of the box. Six wires run through the bottom of the box to two terminal strips. The black, red, and orange wires on one terminal strip are connected to the freezer that is to be monitored. The black, green and blue wires on the other terminal strip provide connection for a second alarm located at another remote point. The contacts in the remote alarm are rated for type II (low voltage) circuit with a maximum current of 1 amp. Normally-open and/or normally closed signals to the remote alarm will allow it to function.

The freezer is supplied with two keyed plugs having 6" three wire pigtails installed in each. These keyed plugs may be inserted in the rear mounted receptacles and the pigtails connected to two remote alarms or, if the second remote alarm is closer to the first than to the freezer, it may be connected at the first remote alarm. In this case there will be a surplus keyed plug.

To connect a remote alarm run the pigtail wires to the remote alarm using the code:
grey to red
yellow to orange
blue to black.

Insert the keyed plug into one of the receptacles in the back of the freezer and plug the power cord into the proper power receptacle.

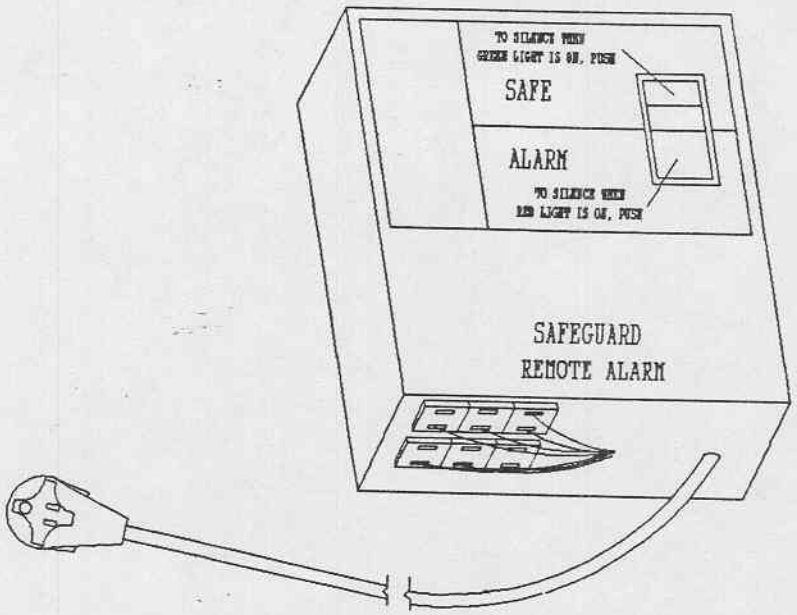


Figure 4...Accessory remote alarm, panel view

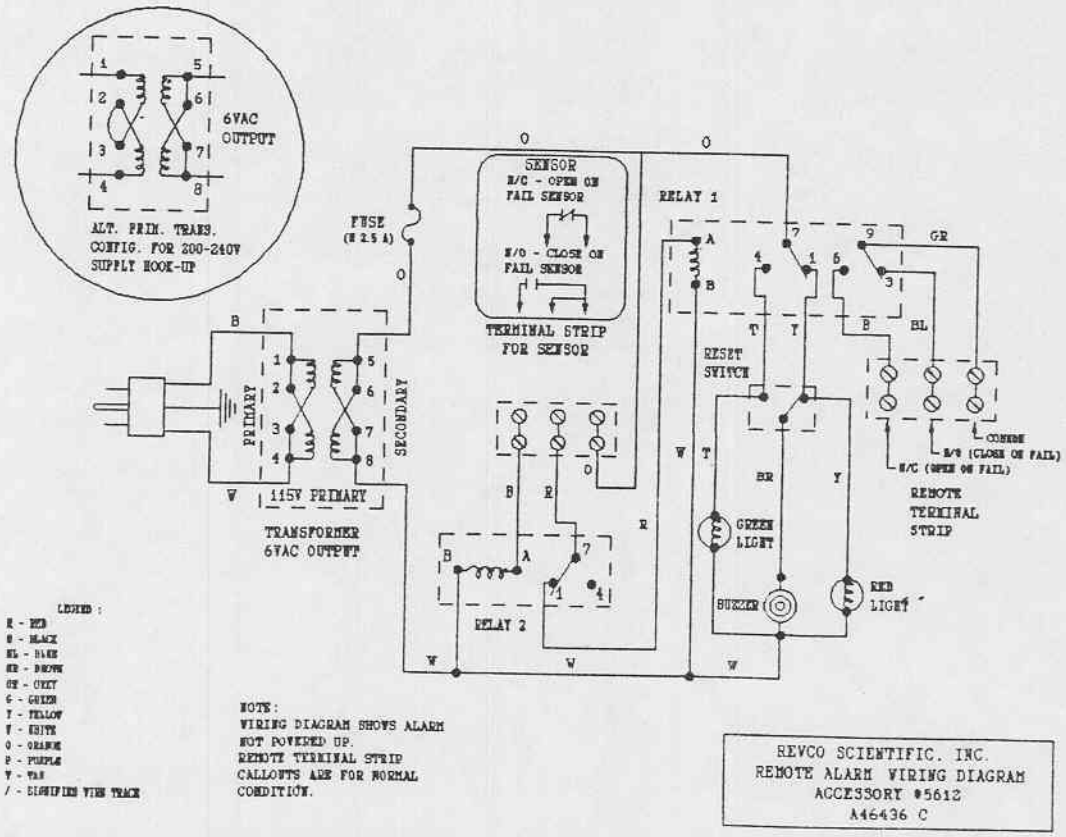


Figure 5...Accessory remote alarm, wiring diagram

REMOTE ALARM OPERATING CHARACTERISTICS.

With the freezer temperature within the set operating limits, the green light on the alarm panel lights. If the reset (rocker) switch is pressed, the red light comes on and the green light goes off and the buzzer sounds. If the green light is on and the freezer goes out of either limit setpoint, the red light and buzzer are activated. Depressing the reset switch will extinguish the red light and silence the buzzer but the green light will not show until the freezer attains temperature once again within the preset limits. When this occurs the buzzer will again sound to tell operating personnel that the freezer is again within preset limits. The reset button may again be pressed and the buzzer will be silenced and the green light will remain on.

In the event that a second remote alarm is connected to the first remote alarm the colored wires are connected using the following code:

green to red
black to black
blue to orange

III. CHART RECORDER (Accessory #6185)
(See Figure 6)

A 6" circular, 7 day chart recorder will be factory installed. See the sketch below.

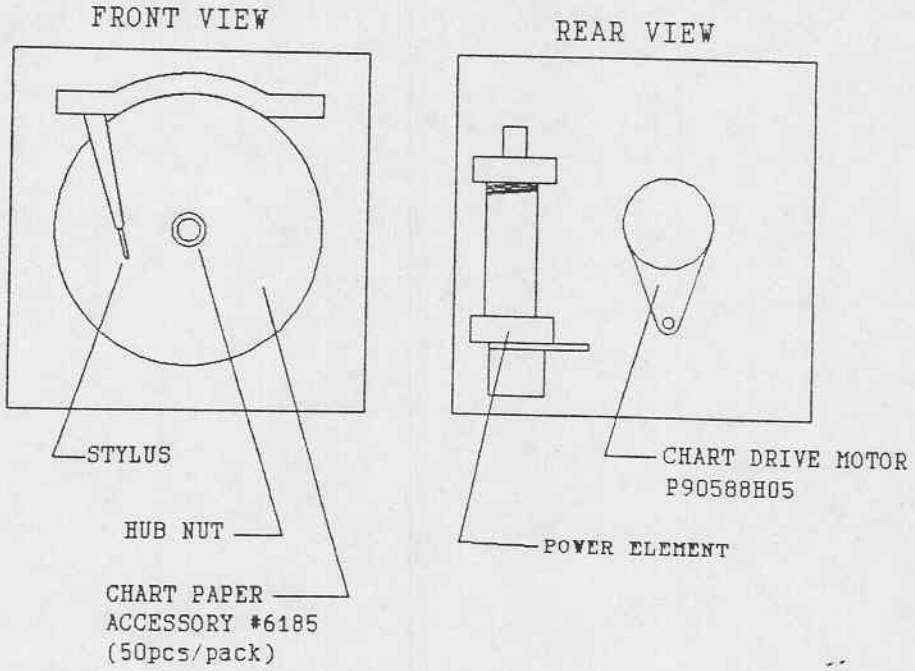


Figure 6...Recorder detail

The chart recorder uses a disc of pressure sensitive chart paper to maintain a seven day running temperature record of cabinet performance. In the event of a power failure the stylus will track with temperature changes, not time.

CHANGING OR INSTALLING NEW CHART:

1. Open the door of the recorder and swing it as far right as possible.

2. Unscrew the hub nut (turn counterclockwise) located in the center of the chart circle (see Figure 6, Page 13). It is retained by a wire and may be left hanging on the right side of the recorder.

3. Gently press on the upper tab of the stylus arm which will lift it off the paper.

CAUTION

Do not allow the stylus arm to snap back against the chart backing plate as the stylus is fragile and subject to breakage.

4. While holding the stylus off the paper, carefully lift the chart paper off the hub and slide it out of the recorder.

5. Place new paper on the hub and align the correct day and time with the white mark on the left side of the recorder at about the seven o'clock position. The stylus may now be lowered onto the chart paper.

6. Replace the hub nut and tighten hand tight while holding the correct chart time in alignment with the white index mark.

7. When placing recorder in operation for the first time check to make sure the red plastic protector has been removed from the sapphire tipped stylus. If this is not done the stylus will not write.

IV. LIQUID CO_2/LN_2 BACKUP REFRIGERATION SYSTEM
(Accessory #4083-MIL)

GENERAL INFORMATION:

BE SURE TO READ THIS INSTRUCTION THROUGH TO THE END AND UNDERSTAND THE VARIOUS STEPS BEFORE STARTING THE INSTALLATION. YOU WILL SAVE TIME.

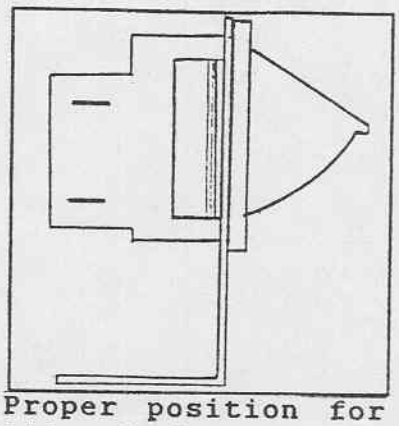
CAUTION!! CARBON DIOXIDE AND NITROGEN ARE NON TOXIC GASES. NOTE CAREFULLY HOWEVER, WHEN RELEASED IN A CONFINED AREA WITHOUT ADEQUATE VENTILATION CAN CAUSE SUFFOCATION.

This accessory, when connected to a user supplied syphon tank of liquid CO_2 OR LN_2, will provide backup refrigeration in case of power failure to the mechanical refrigeration equipment. The control assembly voltage choices for this accessory are 200VAC to 240VAC or 100 to 120 VAC either 50 Hz or 60Hz/10. During power failure the automatic continuously charging battery backup power supply powers this accessory. There are two rocker switches under the main cover. One selects either 115 or 230 VAC nominal power supply and the second selects the user's choice of CO_2 or LN_2 for the expendable refrigerant. Whichever power supply option is selected dictates the power supply cord to be used. Two are shipped with the unit and each is keyed according to NEMA standards and it is impossible for the user to provide the wrong power supply to the control assembly.

Installation: (*See fig. 7 on page 17*)

1. **SETUP** Remove CO_2/LN_2 control unit top cover and place control unit on top of the freezer control console lid. Position it 2" from the freezer lid and with its front panel at the front edge of the control console.

2. **LID SWITCH** Locate the coiled twin lead cord leading from the rear of the control unit, terminating with a two pronged connector and lid activated cutoff switch. Cut the tyraps from the coil, route the lead cord across the top of the control console to the mounting bracket for the lid switch. Insert the lid switch into the mounting bracket which is factory installed on the freezer control console cover.Detach the plug from the switch and snap the switch into the rectangular hole in the bracket, making sure that the curved portion of the switch tripper is at the bottom and is operated by the freezer lid as it closes. Plug the lead cord into the cutoff switch.



Proper position for lid switch

3. Coil the excess lead wire and stow outside the control unit housing.

4. Close and open the lid several times to make sure the tripper is depressed on lid closing and released on lid opening.

5. The control unit may alternately be placed on a shelf just above the machinery compartment providing all the electrical leads and tubing are long enough.

6. **INSTALLING CONTROL BULB AND CO_2 DISCHARGE CAPILLARY TUBE.**

Identify the control bulb assembly mounted in the perforated aluminum housing. Remove the bulb from the housing so that the bulb may be inserted through the access hole in the right rear wall of the freezer compartment. Place the housing on the floor of the tank parallel to the right end wall of the tank in the same relationship to the control bulb so that the bulb will enter the same end of the housing as before it was removed. Also, cut the tyraps holding the coil of capillary tubing to the housing. Remove the coil of capillary tubing and straighten it.

7. **PLACING CONTROL BULB AND CAPILLARY.**

Locate the access port in the right rear wall of the freezer tank. Remove the plastic hole plug and remove the chunk of insulation packed in the hole. Pass the control bulb and CO_2 discharge capillary through the access port and reassemble the bulb in the housing inside the freezer. Bend the capillary tube to the left for now.

8. Mount the housing on the right inside wall of the tank using two 1 1/4" long screws in nylon grommets. Pass the screws through the two 3/8" long nylon standoffs. At this time it must be decided

whether LN_2 or CO_2 is to be the standby refrigerant used. It is possible to install both distribution tubes in order to freely switch from one liquid to the other but it is unlikely that a host facility will have both liquids available. We will discuss installation of both distribution tubes in the following steps.

9. INSTALLING DISTRIBUTION TUBES.

Push the LN_2 discharge tube (the preformed and perforated 1/2" OD stainless steel tube) through the rear access hole and, after removing the screws securing the control bulb housing just installed, slide two nylon clamps over the tube, run the mounting screws through the clamps, and through the standoffs. Slide the bulb housing under the standoffs and retighten the screws. See Fig. 7, Detail A on page 19. Dress the CO_2 discharge tube along the top of the rear tank wall. Locate the retainer strip for this tube which is held in place by the retaining screws for the plastic thermal breaker strips at the top of the tank. Loosen the screws and slip the discharge tube under the retaining strip. Retighten the screws. See illustration 1 on page 19.

LN_2 EXTENSION TUBE. Since this is the only extension tube required because the CO_2 subsystem combines its extension tube and distribution tube into one assembly, its installation will be treated separately. The flare fitting on the right side of the main control unit labelled LN_2 outlet is connected to this distribution tube using the extension tube supplied. This tube is identified as an insulated line having a 1/4" flare nut at one end and 1/2" OD copper tubing cut off square at the other.

10. Connect the 1/4" flare nut to the matching male flare fitting at the rear of the small box at the back of the main control unit labelled LN_2 outlet. Connect the other end to the stainless steel distribution tube installed in paragraph 9 above using the 1/2" brass elbow. **DO NOT REMOVE THE COUPLING NUTS FROM THE ELBOW AS THERE ARE TWO BRASS FERRULES INSIDE THAT DO NOT NEED TO BE REMOVED TO MAKE UP THESE NEXT JOINTS.**

IMPORTANT: FOLLOW THE NEXT INSTRUCTIONS CAREFULLY SO THAT YOUR CONNECTIONS WILL BE MADE TO THE MANUFACTURER'S SPECIFICATIONS AND WILL REMAIN LEAK TIGHT!!

11. Check to see that the coupling nuts are hand tight on the elbow. Remove the plastic plugs from the ends of the coupling nuts, leaving them in place on the elbow. Slide the tubes into the coupling nuts until they bottom in the elbow. While supporting the elbow with one wrench, tighten the nuts with another one and a quarter turns. **DO NOT TIGHTEN MORE THAN THIS.**

LIQUID SUPPLY CONNECTIONS.

The assembly of the CO_2/LN_2 backup system to the cabinet is now complete. It remains to connect the liquid supplies to the control unit.

NOTE:

An uninsulated CO_2 supply cylinder with siphon tube must be

provided by the customer. The siphon tube allows liquid CO_2 to be drawn from the cylinder. The supply pressure must be between 600 and 1050psig. The supply temperature must be between 7 and 31°C (45 and 88°F). This assures the required pressure in the cylinder.

DO NOT INSTALL A PRESSURE REGULATOR BETWEEN THE LIQUID SUPPLY AND THE CONTROL UNIT.

If, when using LN_2, the source is a commercial shipping container, it must also be the liquid dispensing type containing a syphon tube. The liquid in the container is maintained at approximately 28 psig, the liquid is **EXTREMELY** cold and the gas at the top of the container is allowed to escape continuously through a pressure relief valve. There-fore, if you do not have an LN_2 central storage facility these small commercial dewar flasks will self deplete over a 30-50 day period, even without usage. The entire length of LN_2 supply will also be extremely cold while dispensing liquid and the tube is insulated at the factory. Do not remove this insulation for any reason.

If you are unfamiliar with handling compressed gases, refer to Section 600 of this manual.

12. Uncoil the insulated LN_2 supply tubing. Connect the 1/4" flare nut to the supply connection on the right side of the small box at the rear of the control unit, labelled LN_2 Inlet. Connect the 1/2" flare nut to the LN_2 supply connection.

13. Uninsulated CO_2 supply connection is provided complete with fittings by the manufacturer. Connect the end having the large reducing fitting to the syphon tube type CO_2 cylinder and the other end having a 1/4" compression fitting and ferrule to the supply connection on the rear of the main control unit cabinet.

ACTIVATING THE SYSTEM.

14. *BE CAREFUL NOW!* Turn on the CO_2 and/or LN_2 valve SLOWLY and allow pressure to build in the supply tubing before opening the supply connection handvalve fully.

15. Adjust the temperature setpoint to the coldest position.

16. Look at the uncovered control unit and select the required liquid supply and voltage which match your requirements.

17. Connect the proper power cord to the matching control unit and power receptacles.

18. Open and close the freezer lid to insure that the liquid dispenses into the freezer when the lid is closed and flow ceases when the lid is open. If there is no discharge, check to see that the wires are fastened securely to the lid switch and that the switch plunger is actually depressed when the lid is closed.

19. Set the temperature control at a minimum of 5^0C warmer than the operating temperature of the freezer but **never colder than -70^0C.** when using CO_2. Setting colder than -70^0C will result in a continuous dispensing of the CO_2 supply. LN_2 settings may be at -85^0C.

20. Replace cover on control unit. This completes the installation.

Control System Battery Condition:

A. The charge level light comes ON when the battery is below 80% of full charge. It is also possible that the charge level light will come on when the control system is dispensing liquid CO_2 or N_2.

B. When placing the control unit in storage, set the temperature control to $+50^0$C and disconnect the battery by removing one of the leads from the quick connect terminals. The freezer is shipped from the factory in this condition. It assures that the charge in the battery will be retained. The capillary tube leading from the control unit to the control bulb may be coiled up for storage but **do not make coils any smaller than 4 inch diameter.**

CAUTION

Do not turn OFF the supply valve trapping liquid in the supply line. Any rise in temperature will cause a rapid rise of pressure which will rupture the protective disk in the control unit. To correctly turn off the supply valve, first set the control unit temperature control colder until the solenoid opens and liquid begins injecting into the cabinet. Next, turn of the supply valve and allow at least five minutes for the liquid in the supply line to boil off. Next, reset the control to the setting you normally use.

This completes the installation and storage requirements for the backup refrigeration system.

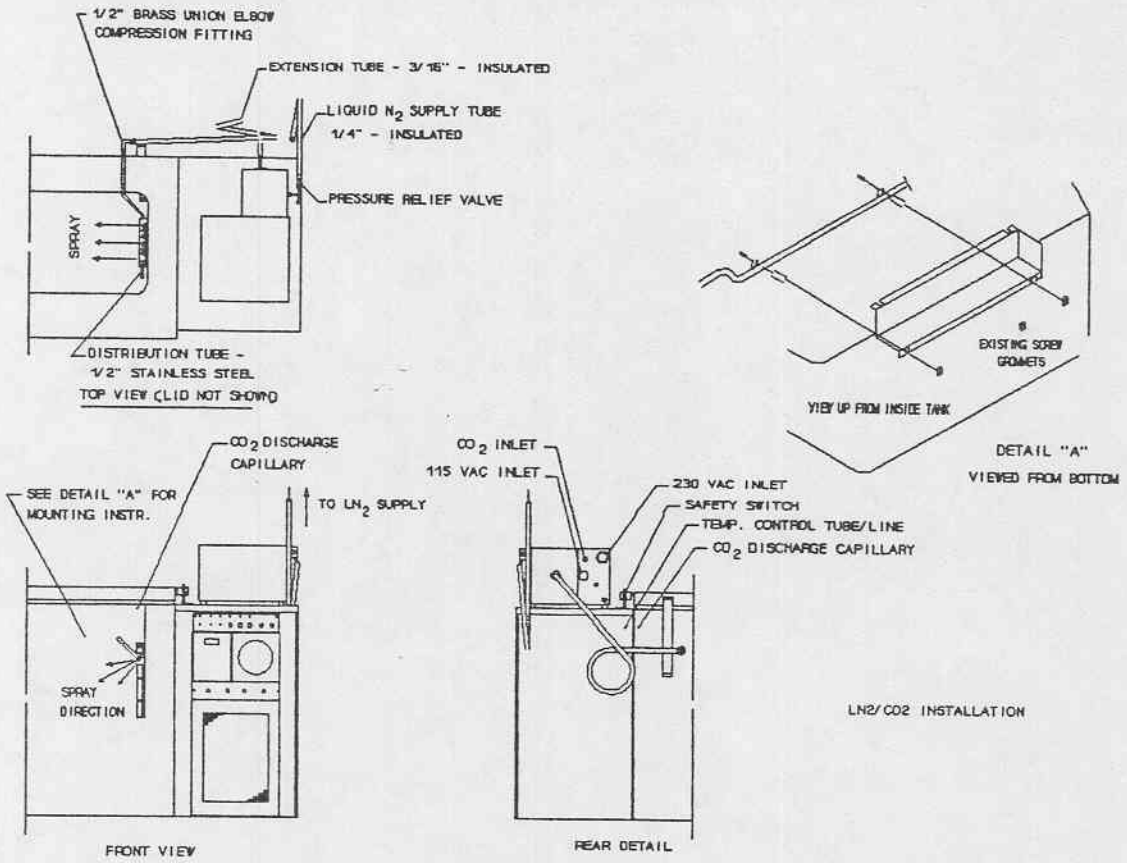


Fig. 7...LN_2/CO_2 Backup System Installation.

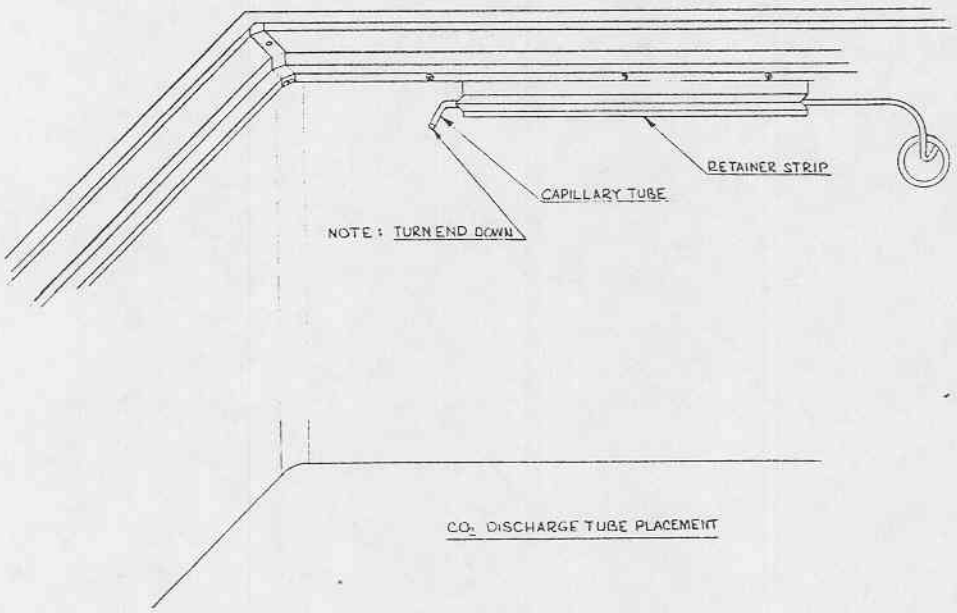


Illustration 1...CO_2 Discharge Tube Placement.

IV. VOLTAGE SAFEGUARD (Optional, not in contract)
(See Figure 8 and Figure 9)

The 3-phase, 208VAC/30/60Hz or 220VAC/30/50Hz Voltage Safeguard is designed to correct voltage that drops below factory specifications for the MBF-500 freezer. It is capable of boosting voltage by 6.5%.
The illustration below shows the unit status indicator panel.

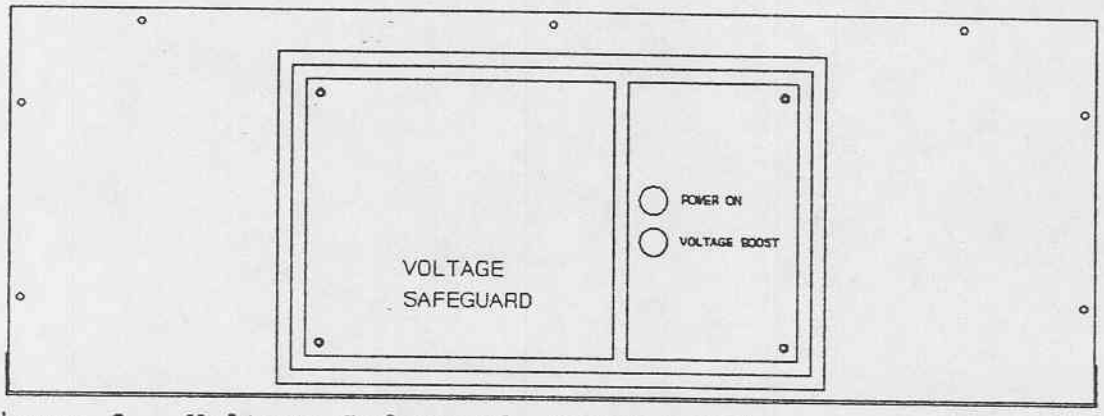


Figure 8...Voltage Safeguard, front panel

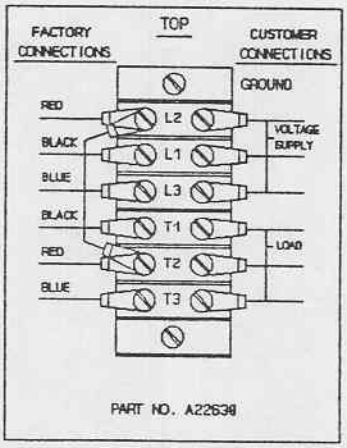


Figure 9...Voltage Safeguard, connections

FREEZER SEQUENCE OF OPERATION

DO NOT ATTEMPT TO OPERATE THIS FREEZER UNTIL YOU COMPLETE THE INSTALLATION CHECK LIST THROUGH NUMBER 15. THEN READ THIS SEQUENCE OF OPERATION.

I. INSTALLATION CHECK LIST

1. The freezer is in place. ____
2. The freezer has been leveled. ____
3. Check freezer data plate voltage. (208VAC/30/60Hz or 220VAC/30/50Hz) ____
4. Check supply voltage is the same. ____
5. Check that power panel circuit protection rating does not exceed that indicated on the data plate. (Max 18.5amp on 60Hz and Max 17.4amp on 50Hz) ____
6. Freezer and Voltage Safeguard have been wired by qualified electrician. 3 phase power is required. ____
7. Remote Alarm installed and terminals connected (See page 11, Figure 4 and Figure 5). ____
8. Compressor shipping bolts have been loosened (See page 21, Figure 11) ____
9. Checked - No product load in freezer. ____
10. Chart paper installed in recorder. (See page 12 & 13,Figure 6) ____
11. Plastic protector removed from recorder stylus. ____
12. Main Building power panel breaker on. ____
13. Using key provided, turn on the compressor key switch. ____
14. Setting primary control set points. (See Figure 10) ____

    NOTE: When changing the set points indicated below with adjusting screws (key #4,5, & 6), clockwise (CW) is warmer and counterclockwise (CCW) is colder.

    A. Depress scan button (key#7) until LED for temperature set point is lit (key#1a). Turn cabinet temperature setpoint adjusting screw (key#4) until the desired temperature is shown on the digital display (key#12).

    B. Depress scan button until LED for cold alarm set point (key#1b) is lit. Turn cold alarm setpoint adjusting screw (key#5) until the desired temperature is shown on the digital display (key#12). It is recommended that this setting be 10°C colder than the control setpoint.

    C. Depress scan button until LED for warm alarm set point (key#1c) is lit. Turn warm alarm setpoint adjusting screw (key#6) until the desired temperature is shown on the digital display (key#12). It is recommended that this setting be 10°C warmer than the control setpoint.

15. Check the breaker strip condensate heater switch (key #17, Fig. 10). This switch is shipped from te factory in the OFF position. Turn this switch ON only if the humidity is expected to be extremely high which may cause frost on the breaker strips.

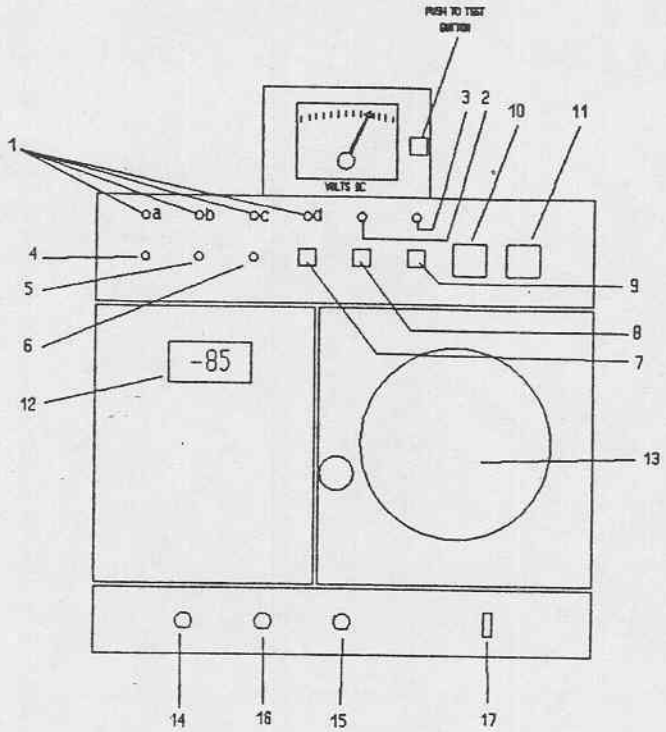


Figure 10..Control Panel Detail

1. Indicator LED's for display modes.
   a. Cabinet temperature setpoint (amber)
   b. Cold alarm setpoint (amber)
   c. Warm alarm setpoint (amber)
   d. Cabinet temperature (green)
2. Temperature failure LED (red)
   "ON" when cabinet temperature has exceeded set alarm points.
3. Power failure LED (red)
   "ON" when AC power is not available at the freezer.

   NOTE: A flat blade screwdriver with a 1/8" wide x approx. 3 " long will be required to adjust setpoints at items 4,5, & 6.

4. Cabinet temperature setpoint adjusting screw. Sets control set point.
5. Cold alarm setpoint adjusting screw. Sets cold alarm point.
6. Warm alarm setpoint adjusting screw. Sets warm alarm set point.
7. Scan button. Sets parameter diplayed in digital display.
8. Audio silence button. Temporarily silences local audio for 5-7min.
9. Alarm test button. Provides test of warm alarm point.
10. Key-operated alarm ON/OFF switch. Turns on local audio alarm.
11. Key-operated compressor ON/OFF switch. Turns on power to compressors and control system.
12. Digital temperature indicator.
13. Temperature recorder, 7-day, 6" diameter.
14. System "B" indicator light. "ON" when system "B" 2nd stage running.
15. System "A" indicator light. "ON" when system "A" 2nd stage running.
16. Alternate system alarm indicator light.
    "ON" when auxiliary control causing both systems to operate.
17. Heater switch. Operates breaker strip condensate heater.

Panel meter reads alarm battery voltage when pushbutton is pressed.

NOTE: THE ALARM KEY SWITCH MAY BE LEFT IN THE OFF POSITION UNTIL THE CABINET HAS COME DOWN TO OPERATING TEMPERATURE. THIS WILL SILENCE THE ALARM UNTIL THE FREEZER TEMPERATURE IS COLDER THAN THE WARM ALARM SETPOINT.

When the Compressor keyswitch (Fig. 10, key#11) is initially turned ON, the digital temperature display (Fig. 10, key#12) will show "-00" or "-01". When the freezer has cooled below -1^{0}C, the digital display will begin to read actual cabinet temperature. Pressing the scan button, will cause the display to change from reading cabinet temperature to one of the other parameters such as high or low alarm setpoint. As this button is repeatedly pressed it scans through the readable parameters, illuminating in turn each indicator light above its adjusting screw. As each light is illuminated the external digital temperature display window will indicate that parameter. As the last indicator light comes on the actual cabinet temperature will be displayed. Scanning through these parameters will not change any of the previously selected temperatures.

NOTE

It is normal for the top flange of the freezer cabinet to be warm during operation of the systems. This is particularly true when the chamber is first pulling down in temperature.

Within six minutes from the time the compressor power key switch is energized both first stage compressors will start. They will run until the reverse acting pressure controls (RALPC) in the high stage system senses a pressure corresponding to -40 ^{0}F., at which time the contact points will close. Since these points are connected electrically in the low stage control circuit the low stage compressors will start. All four compressors will run continuously until cabinet temperature has dropped to the setting of the auxiliary temperature control setpoint. At this time, one cascade system will shut down and the second cascade system will continue operating until the electronic control setpoint is achieved. Once the freezer has reached a cycle condition, the rate of cycling of the systems is affected by ambient temperature, humidity, amount of product load, and actual usage and alternate cycling of systems A and B will occur.

CAUTION: DO NOT ADD ANY PRODUCT LOAD TO A WARM CABINET.

The system is protected against overloading through the action of the reverse acting pressure control in the electrical circuit of the second stage however; prolonged overloaded operation will shorten the life of all refrigeration compressors and should be avoided by loading product only after the cabinet interior is at operating temperature.

II. LOADING FREEZER

NOTE:

When loading the freezer, leave a minimum space of two inches (2") between the under side of the freezer sublid and the top of the top-most packages for proper air circulation.

EXTREMELY IMPORTANT!!!

OBTAINING MAXIMUM CAPACITY FROM YOUR BLOOD FREEZER

Array:

1. Blood boxes must be stacked with the 7 inch box dimension parallel to the side of the freezer.

2. Make three stacks back to front 12 boxes high.
3. Remove 4 boxes from the top layer to make a total of 500 boxes.

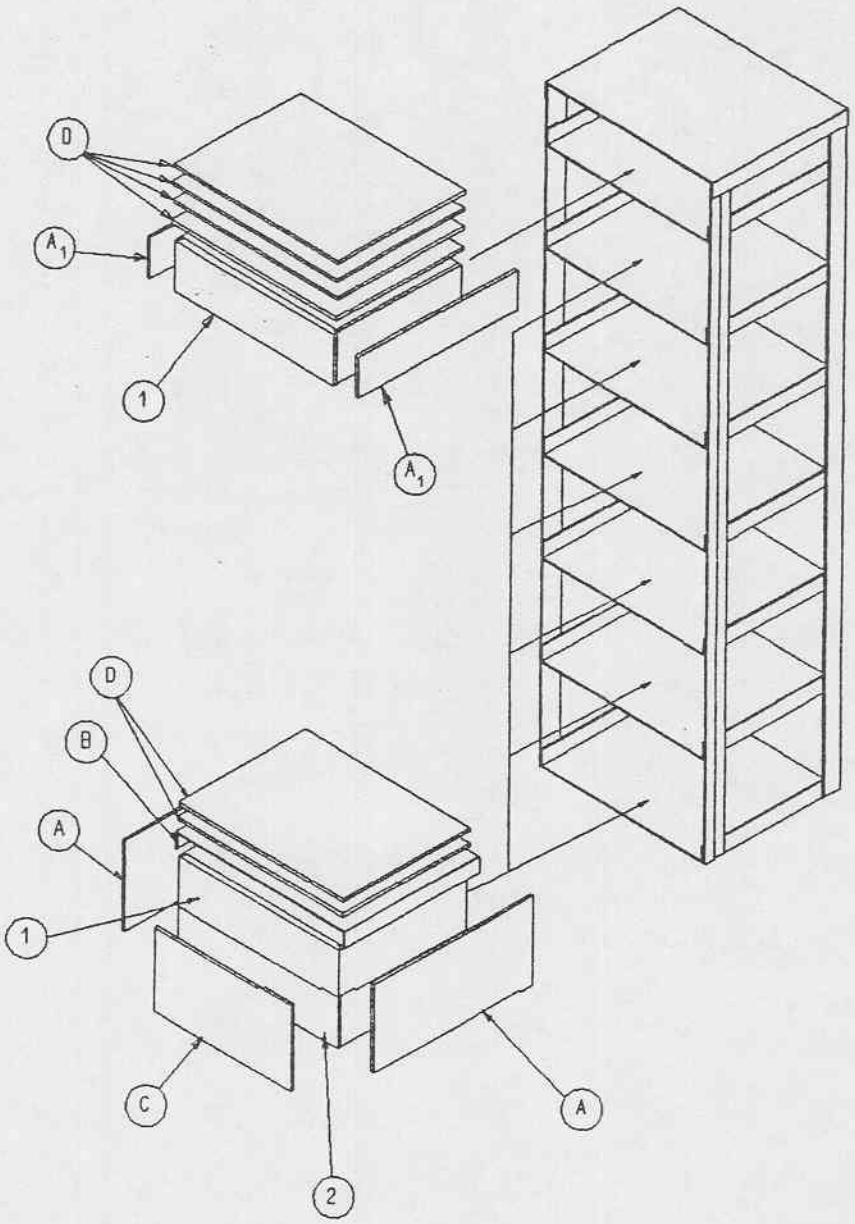


Fig. 11...Holding box dimensions while freezing bags

The next few paragraphs and accompanying drawing indicate a method for freezing primary blood bags in a restrictive press to assure uniformity of box size and resultant optimum use of the MBF-500 freezer storage capacity. at **NO MORE THAN 500 BOXES.**

The parts needed are as follows:

1. 1-Thirteen box optional storage rack.
2. 6-Extra loose, standard shelves used in the storage rack.
3. 2-Side shims 1.5" x 6.85" x 1/8" thick plastic (polypropylene or PVC.
4. 12-Side shims 3.4" x 6.85" x 1/8" thick plastic.
5. 16-Top of box shims 5.5" x 7.2" x 1/8" thick plastic.
6. 6-Front of box shims 3.25" x 6.85" x 1/8" thick plastic.

Assembly of press: See Fig. 11 on page 24.

1. Stand the rack vertical on a table. Work from the bottom up.
2. Slide the boxes "1" and "2" onto the shelves with the front of one box on each shelf facing forward and one backward. One box goes on the topmost shelf.
3. Slide 6 loose shelves "B" into the rack, positioned on top of each pair of boxes with its flange facing downward. No extra shelf is needed on the top box.
4. Lay the rack down on its back.
5. Slide in 12 side shims "A", two at each pair of boxes. These shims must be installed between the box and the flanges on the shelves so as to avoid deforming the boxes.
6. Slide in 2 side shims "A_1" at the sides of the topmost box.
7. Slide in 2 Top of Box shims, "D" on top of each pair of boxes, working from the bottom to the top.
8. At the top box, slide in 4 Top of Box shims, "D".
9. Tap all shims to the rear, making sure the Top of Box shims are all the way to the back of the rack so that the retaining rod will enter the holes at the front of each shelf.
10. Place all Front of Box shims "C" at each pair of boxes. The top box does not require one.
11. Slide the front retaining rod in place from the top to the bottom.
12. The 13 boxes are now ready for freezing. Repeat the packing and freezing process as many times as necessary.

The cabinet is insulated with nominal 5" of foamed-in-place polyurethane insulation.

CAUTION

DO NOT DISCARD THE SUB LIDS. THEY ARE NECESSARY FOR THE PROPER OPERATION OF THE FREEZER.

REDUNDANT SYSTEMS DESCRIPTION

This freezer is equipped with redundant cascade refrigeration systems. System "A" and System "B" are identical systems and <u>each</u> capable of maintaining the proper temperatures inside the freezer. During a normal cycling condition, a sequencing relay, under control of the electronic control board, cycles first one system and then the other in order to equalize operating time on both systems. When the cabinet is warm and during pulldown however, both systems will run since the sequencing relay is overridden by a secondary mechanical temperature control. The red "Alternate System Alarm" light on the lower status indicator panel will be lighted. When both systems operating have cooled the cabinet down to the

required temperature, the secondary temperature control shuts down one of the operating systems and the alternate system red warning light will be extinguished. The second system will continue to run until the cabinet temperature has lowered to the primary control set point. At that time the operating system will shut down. Upon cabinet warmup to the electronic control board set point, the "lead" system (as determined by the position of the sequencing relay contacts) will start. When the cabinet control setpoint is once again reached, the sequencing relay will be de-energized and will exchange the lead systems. The amber pilot lights on the lower status indicator panel indicate which system is in operation but, it must be remembered that they are not lighted until the second stage compressors of each system have come on line. An auxiliary safety thermostat has been provided (See Figure 17) that will put both systems in operation if the cabinet temperature rises above its setpoint.

NOTE: THE FOLLOWING EMERGENCY OPERATING PROCEDURE SHOULD BE USED ONLY BY PERSONS TRAINED IN ELECTRICAL WORK AND COMPETENT TO OPEN THE CONTROLS SECTION OF THE FREEZER.

The factory has set this thermostat 3-5 degrees warmer than the desired cabinet operating temperature. When this safety thermostat functions, it indicates that the second cascade system has been required to maintain prope temperature. This can be the result of a significant heat load added to the freezer or, it can mean that the system operating as primary at the time it occured has a problem. If a failure occurs the unit involved may be switched off by placing the appropriate manual override switch in the center or off position. There are two of these 3-position switches located in the control panel junction box next to the auxiliary thermostat. See Junction box Layout drawing. The other manual switch is then moved to the bottom or bypass position. To return to normal operation both switches are returned to the top or cycle position.

MOUNTING DETAILS FOR COMPRESSORS

Some motor-Compressors are mounted using the assembly illustrated at the right. When units are shipped from the factory the motor compressors are rigidly secured to the base by the mounting components. Before these units are placed into operation the 1/2" top mounting nut must be loosened to allow the compressor to float on the springs. Using a 1/2" combination box and open end wrench, loosen the nut enough for 1/16 inch clearance between the nut and neoprene spacer. If subsequent shipping is necessary, retighten the upper nuts. MBF500 units and all others for shipboard use are mounted rigidly with a short length of steel pipe replacing the spring and lower rubber mount. Nothing needs to be loosened on this latter type mount.

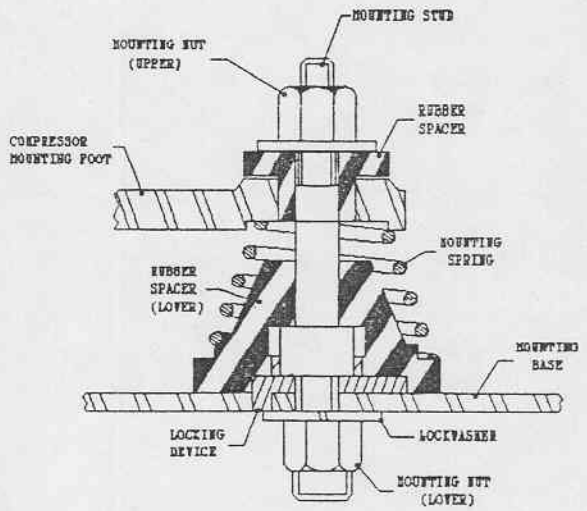


Figure 12...Compressor mounting detail

CARE AND PERIODIC MAINTENANCE

I. Air Cooled Condenser Filter:

The filters for the air cooled condensers should be cleaned a minimum of once every six months of operation. Cleaning more frequently should occur if the operating environment is likely to cause a buildup of dirt in the tube/fin condenser. The filter media can be seen through the filter grill at each end of the freezer in the front. When the filter media pattern can no longer be distinguished, cleaning needs to accomplished.

Access to each filter is obtained by:

1. Turn OFF the compressor key switch and disconnect the electrical service to the freezer.
2. Remove the eight (8) screws at the outside edge of each front grille.
3. After removing the front grilles, remove the two wire filter retainers by bending slightly.
4. Remove the filter material and wash in any standard hand dish washing detergent. Rinse and shake out the water. Pat dry with an absorbent cloth.
5. Replace the filter into the grill and replace the wire retainers.
6. Check the fins of the condenser to insure that they have not been contaminated with dirt passing through the filter. Clean as necessary.
7. Replace the front grilles and screws.
8 Restore the electrical power to the freezer and turn ON the compressor key switch.

II. Cleaning The Freezer Surfaces:

The inside and outside of the freezer are coated with a heat fused epoxy powder finish. It may be cleaned with any non-abrasive cleaner such as hand dish washing detergent. To prevent odors on the inside of the freezer after cleaning, it is recommended that, after cleaning with detergent, the entire surface be wiped with a clean cloth soaked with a solution of one half (½) gallon of water and one quarter (¼) cup of baking soda.

III. Drain Connection:

There is a 3/8" female pipe connection in the front of the freezer and at the top of the machine compartment. When defrosting and cleaning out the tank, it is advisable to connect a short piece of pipe and a hose to this drain and lead it to the nearest disposal utility.

STORAGE:

When placing this freezer in storage, open the lid, and allow the interior to warm up to ambient temperature. Dry out the interior. Prop the lid open at least 6" and secure in this position. If freezers are in storage fully crated, periodic inspection and service is accomplished by removing the front panel of the crate. Remove approximately 16 wood screws and set the panel aside. Swing open the hinged control panel cover.

SECTION 400.

REFRIGERATION SYSTEM

REFRIGERATION SYSTEM THEORY OF OPERATION

Refrigerant liquid will evaporate to provide low temperatures if the pressure in the containing vessel (evaporator) is kept low. The lower this pressure is maintained while the refrigerant is evaporating into a vapor, the lower will be the temperature of the evaporating liquid. Very special refrigerants are chosen for extra low temperature applications so that their characteristics will match the compressors available to change the evaporated gas back to a liquid.

Simply compressing these special refrigerants will not cause them to change back to the liquid state. They must be cooled to a low temperature and then liquefaction will take place.

The means to accomplish this cooling and liquefaction of a compressed gas is with a second complete and separate refrigeration system. This design is called cascade refrigeration and is the design used in the MBF700 Low Profile freezer.

The actual design employs a cascade condenser which is cooled not by normal temperature air or water but by the first stage refrigeration system. This first stage system is then cooled by a normal temperature medium such as air or water. Refer to the simplified diagram explaining this concept on the next page.

A further refinement incorporated into this freezer is refrigeration system redundancy. This means that there is a completely independent system in addition to the one just described above included in the cabinet. The control of these two systems has been explained in the Sequence of Operation discussion preceding.

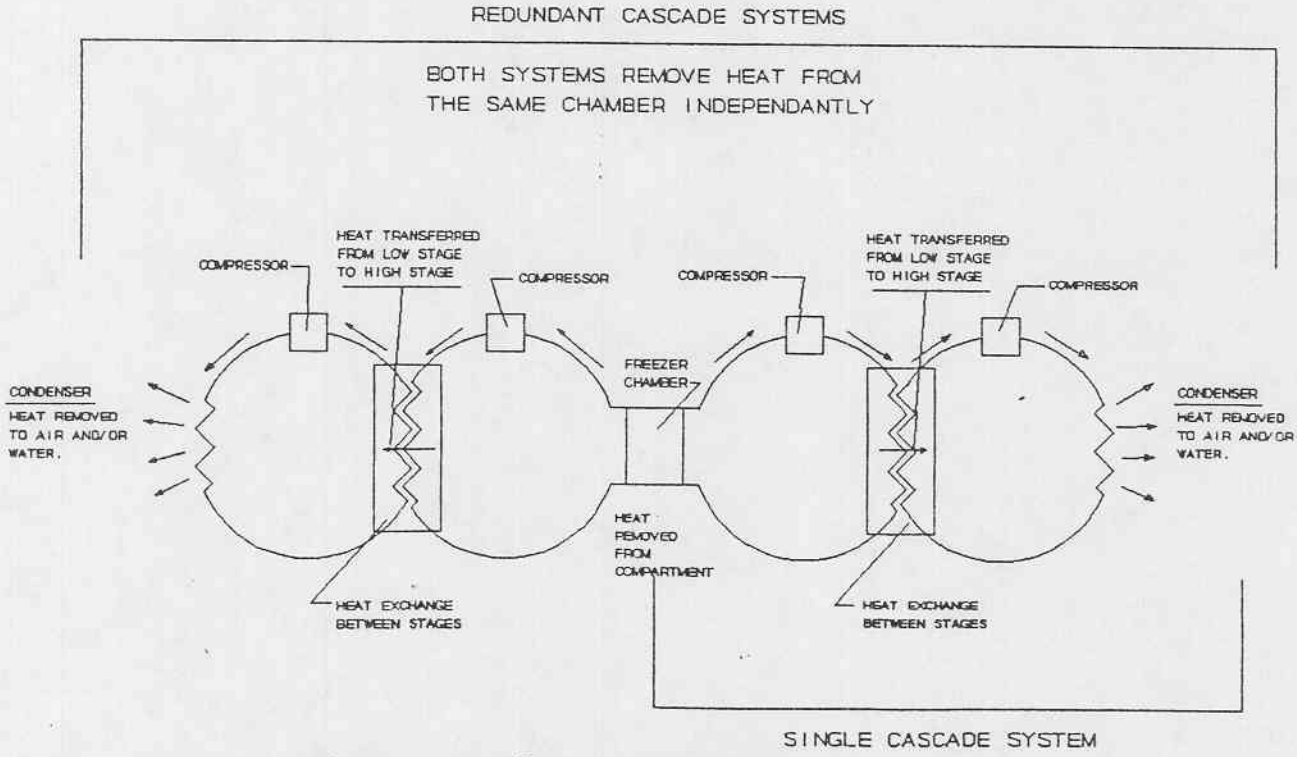


Figure 13...Redundant cascade system diagram

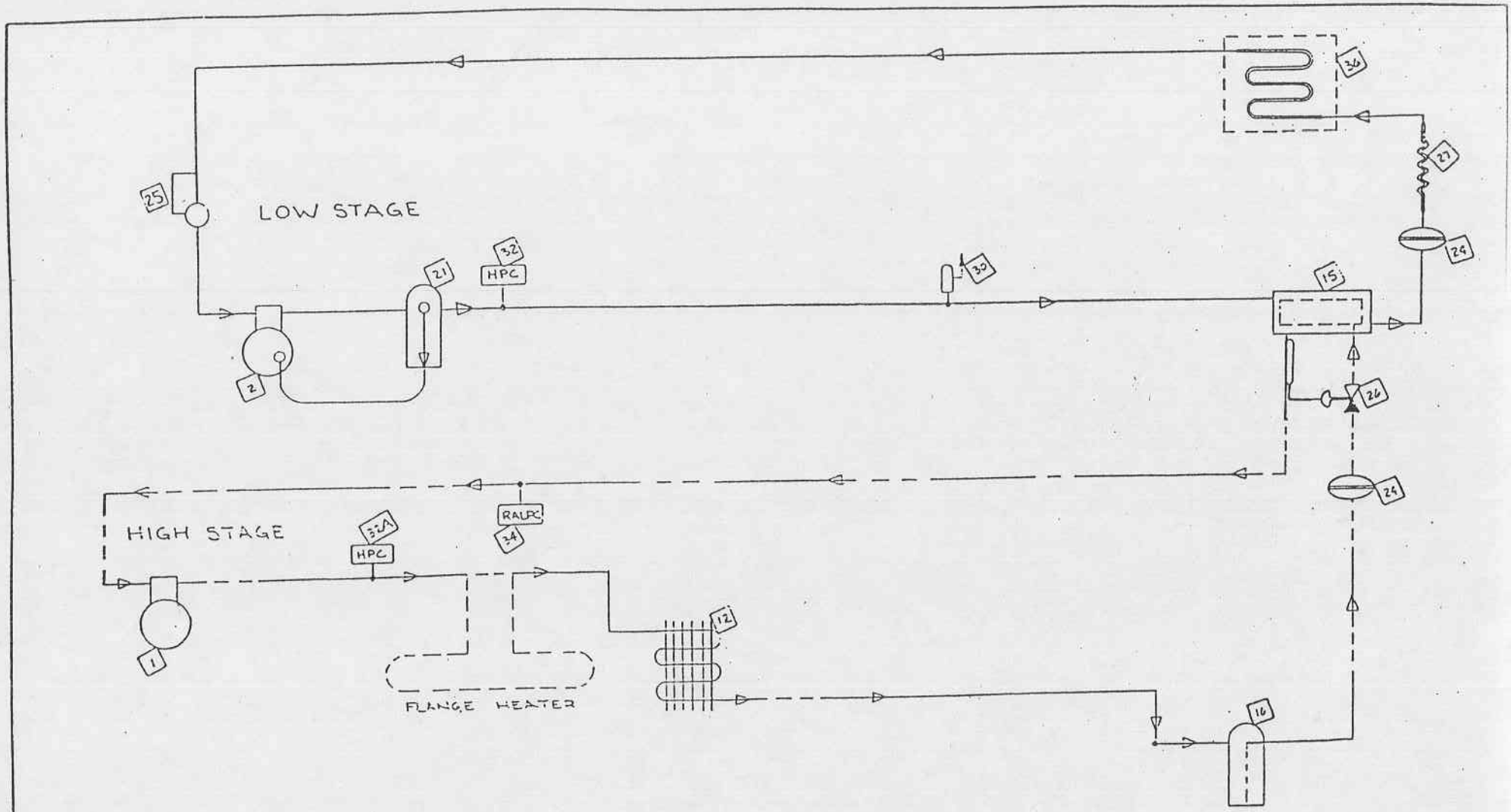
SECTION 500.

DRAWINGS

Key List

FLOW DIAGRAM B87383
AIR COOLED

Key No.	Part Number	Description	Qty
1,2	S69949H20	COMPRESSOR, KAK1-0100-TAC 208-230VAC/30/60hZ	4
12	M76968H01	CONDENSER, AIR COOLED	2
15	N75455H01	CASCADE CONDENSER (Not serviceable)	2
16	N88945H01	RECEIVER	2
21	A81475H01	OIL SEPARATOR	2
24	N75380H01	DRIER, REFRIGERANT	4
25	S49232H01	CRANKCASE PRESSURE REGULATING VALVE, CROT	1
26	P49224H09	VALVE, THERMOSTATIC EXPANSION	2
27	S47417H33	TUBE, 2ND STAGE CAPILLARY	2
30	A68762H01	VALVE, PRESSURE RELIEF	2
32	B45286H01	CONTROL, HI PRESS. CUTOUT SET 275/120	2
32A	B48575H03	CONTROL, HI PRESS. MANUAL RESET	2
34	S75462H01	CONTROL, REVERSE ACTING LOW PRESS.	2
36	NA	TUBING, EVAPORATOR, Not Serviceable	2



NOTE:

Only one Refrigeration System is shown.
Both systems are identical and refrigerate liner independently.

DRAWN R. G.	SCALE ~			
DATE 6-14-90	JOB NO.	LTR	REVISION	DATE
HARRIS MANUFACTURING CO.			DWG NO. B23625	
TITLE FLOW DIAGRAM (AIR)				REV.

KEY LIST

WIRING DIAGRAM B85240 C
(Figure 15)

Key No.	Part No.	Description	Qty.
7	A64151H02	Switch, SPDT (SW-1,SW-2)	1
7A	A64151H01	Switch, SPST	1
10	S49200H01	Light, amber indicator	2
10A	S49200H02	Light, red indicator	1
12	S41026H62	Transformer, 240VAC/12VAC	1
15&65	S69949H20	Compressor, KAK1-0100-TAC 208-230VAC/3Ø/60Hz	4
16	N80504H01	Contactor, 230VAC/30A/3P (C1,C2,C3,C4)	4
25	A69156H02	Fuse, 3.2A/250VAC	2
28	B45829H01	Control, temperature	1
29	D46433H07	Recorder, UE 650 skeleton	1
35	N90588H08	Motor, Recorder, 230 VAC/1Ø/60Hz	1
32	B45826H01	Control, pressure 275/120 (HPC-2A,-2B)	2
32A	B48575H03	Control,pressure, manual reset (HPC-1A,-1B)	2
34	S75462H01	Control,reverse acting #P70CA-117(RALPC-A,-B)	2
40	S63647H01	Relay, solid state 0.3amp (R8)	1
41	A44569H07	Relay, 3PDT/240VAC (R4)	1
43	N75901H01	Relay, sequencing, Solid State	1
	M75900H01	Socket, Relay	1
44	S44569H06	Relay, 3PDT/12VAC (R6,R9)	2
51	M84077G01	Heater, (20ft/80 ohms per ft)	1
66	A61669H01	Motor, fan, 35 watt, 230VAC/1Ø/50-60Hz	2
67	B5433 H01	Motor, fan, 14 watt, 230VAC/1Ø/60Hz	2

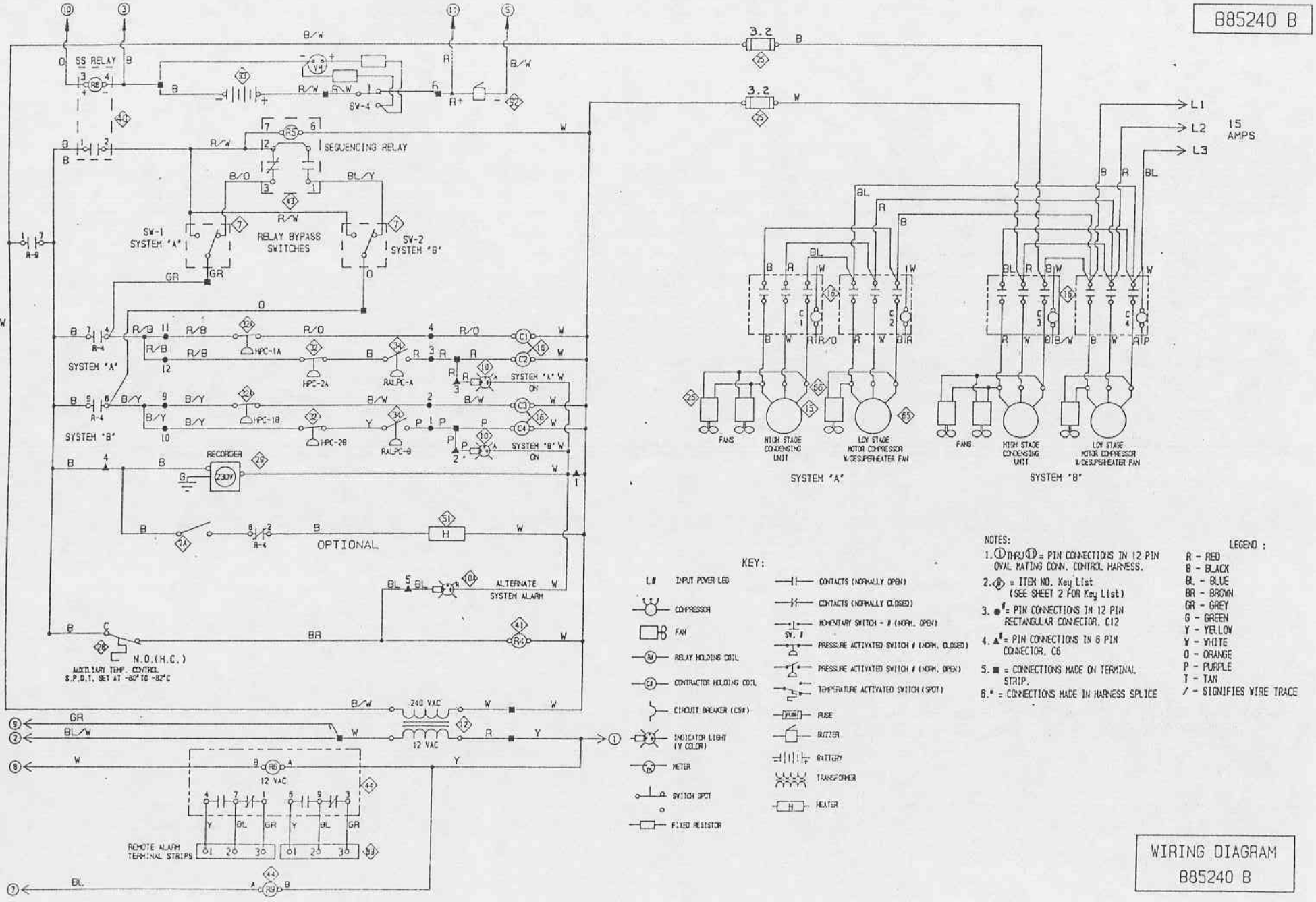


Figure 14...Cabinet wiring diagram

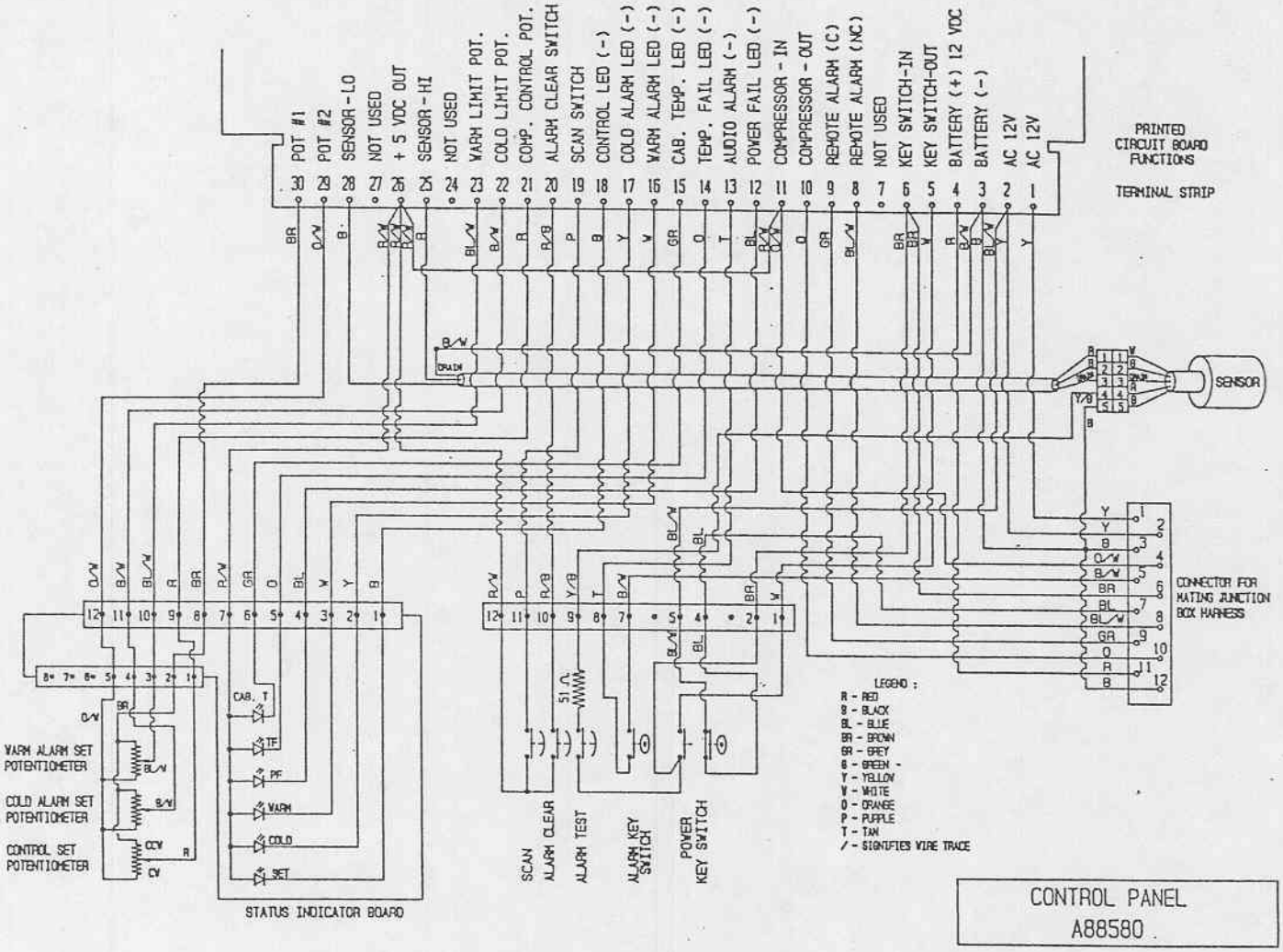
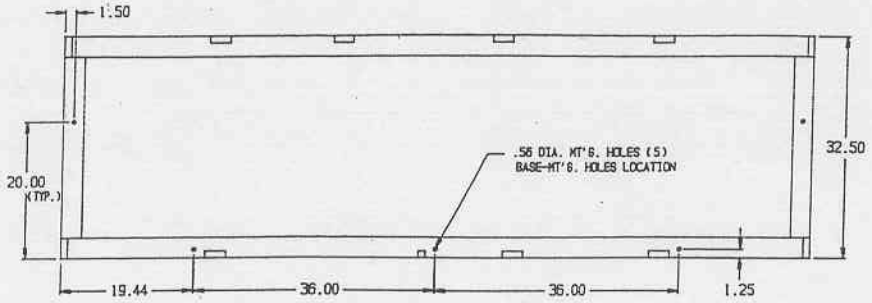
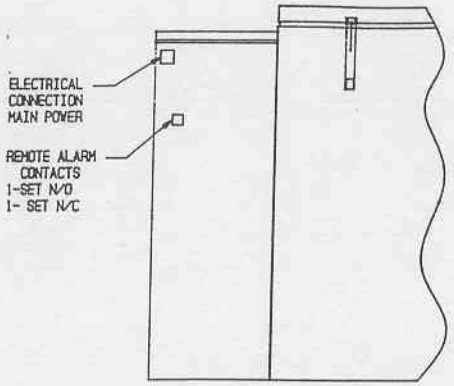
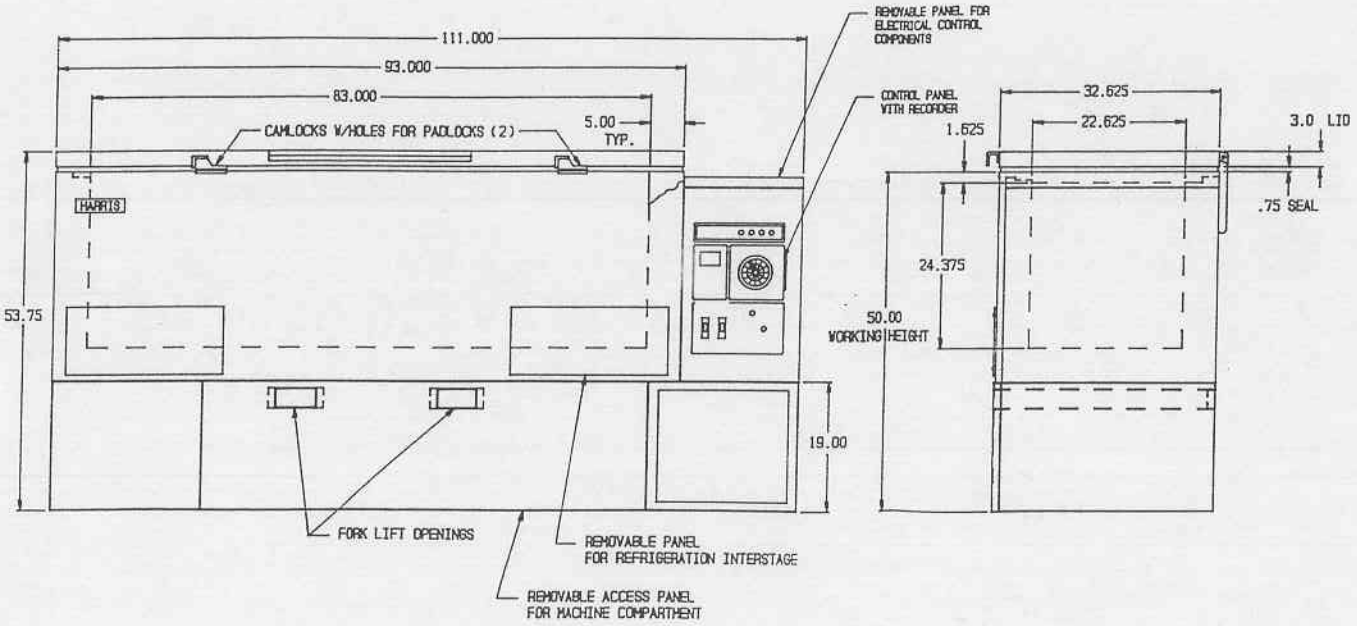


Figure 15...Control wiring diagram







1. STORAGE CAPACITY	504 UNITS
2. CHAMBER VOLUME	26.5 FT.^{3}
3. PRODUCT VOLUME	22 FT.^{3}
4. PRODUCT WEIGHT	611 LBS.

PRODUCT ARRANGEMENT

UNITS LEFT TO RIGHT	14 (5.63)
UNITS FRONT TO BACK	3 (7.06)
UNITS HIGH	12 (1.88)

NOTE: PRODUCT TO BE HANDLED IN BUNDLES OF SIX (6). EACH BUNDLE = 7.28 LBS.

ELECTRIC REQUIREMENTS

VOLTS	PHASE	HERTZ	AMPS	WATTS
208 / 230	3	60	20 (17.4)	8000
200 / 220	3	50	20 (18.4)	7600

HEAT REJECTION IN BTU / HR TO ROOM
AIR COOLED 9200

WEIGHT (LBS.)
EMPTY 1600
SHIPPING 1850

SHIPPING CRATE (INCHES)
119 x 40.625 x 68.25 HIGH

HARRIS MANUFACTURING CO.	
SCALE: NONE	DRAWN BY: HBD
DATE: 2-23-89	REVISED: 10-12-90
GENERAL ARRANGEMENT MBF 500	
	B82823 C

6...Cabinet outline drawing

SECTION 600.

CASCADE REFRIGERATION

CASCADE REFRIGERATION NOMENCLATURE

PLEASE NOTE: THIS INFORMATION IS INTENDED TO HELP THE EXPERIENCED REFRIGERATION TECHNICIAN TO UNDERSTAND SOME OF THE TERMS USED IN SERVICING CASCADE REFRIGERATION. DO NOT ATTEMPT TO SERVICE THIS TYPE EQUIPMENT WITHOUT PRIOR EXPERIENCE.

AZEOTROPIC MIXTURE

A mixture whose vapor and liquid phases have identical compositions at a given temperature. In the context of refrigerants such a mixture is made up of two or more refrigerants which when mixed exhibit properties of a new refrigerant having properties different from any of the components. Examples of such mixtures are: R-500, R-502, and R-503.

BACK PRESSURE

The compressor suction pressure normally read at the compressor suction service valve gauge port.

CASCADE REFRIGERATION

The design technique of using two or more separate refrigeration systems in which the cooling effect (evaporator) of one system cools the condenser of another. The evaporator of this latter system providing the cooling for the process.

DRIER

More exactly, refrigerant filter-drier. This device contains a physically stable chemical desiccant formed into a cylindrical cake. This device becomes a molecular sieve and moisture removal appliance in one package.

EVACUATION

The process of drawing a deep vacuum on a system by means of a high vacuum pump to remove contaminants such as non-condensable gases and moisture.

HEAD PRESSURE

The compressor discharge pressure normally read at the compressor discharge service valve gauge port.

HIGH SIDE

All parts of a system which run at the highest pressure; technically everything from the compressor discharge valves to the refrigerant metering device be it a thermostatic expansion valve or a capillary tube.

HIGH STAGE

The complete high temperature system.

CASCADE CONDENSER

The condenser for the low temperature system. This condenser is cooled by the evaporator of the high stage and since these two components must be in close contact, the construction of this condenser takes the form of a tube-within-a-tube heat exchanger.

LOW SIDE

All parts of a system which run at the lowest pressure: technically everything from the outlet of the refrigerant metering device to the compressor suction valves.

LOW STAGE

The complete low temperature system.

MICRON

A unit of linear measure in the Metric System. It is one millionth of a meter. When used in vacuum measurement it is the measurement of the height of a column of mercury supported by the remaining pressure in the system. Since there are 39.37" in a meter it can be seen that one micron = 39.37/1,000,000 = .00004". This also relates to sea level atmospheric pressure at 0.0 psig or 759,970 microns. This relationship is important to any discussion of adequate evacuation of refrigeration systems especially the cascade type of ultra low temperature systems which are normally evacuated to 100 microns or less.

OIL SEPARATOR

That component of a refrigeration system which is designed to remove oil from the discharge gas stream from the compressor, collect it into a reservoir and then return it to the compressor crankcase thus preventing the oil from entering the evaporator. This device is never 100% effective but, will remove 90% of the oil from the discharge gas.

SUPERHEAT

The term superheat as applied to a vapor is used to describe a gas whose temperature is above its boiling or saturation point. To apply this definition to the refrigeration system one needs only to understand that when liquid refrigerant is boiling in the evaporator of the system any vapor formed is saturated because it is in contact with liquid refrigerant at the same temperature. As the evaporated refrigerant gas travels from the evaporator through the suction line and back to the compressor it picks up additional heat and this is the superheat. This heat is sensible heat. In other words, it raises the temperature of the vapor and therefore this heat can be sensed. The suction line is then measurably warmer than the liquid and vapor that are still in the evaporator.

THE FOLLOWING CHART INCLUDES REFRIGERANTS OTHER THAN THOSE USED IN ULTRA LOW TEMPERATURE REFRIGERATION SYSTEMS

REFRIGERANTS

CYLINDER IDENTIFICATION:

R-12 Dichlorodifluoromethane (CCl_2F_2).....White*

R-13 Chlorotrifluormethane ($CCLF_3$.....Light blue/ dark blue band*

R-14 Carbontetrafluoride (CF_4).....Gold*

R-22 Chlorodifluoromethane ($CHClF_2$).Medium green*

R-290 Propane (Flammable) (C_3H_8)..Pink/brown band*

R-500 Mixture,....Dichlorodifluoromethane/Difluoroethane ($CHCl_2F_2/CH_3CHF_2$).....Yellow*

R-502 Mixture,..Chlorodifluoromethane/Chloropentafluoroethane ($CHClF_2/CClF^2CF_3$).....Purple*

R-503 Mixture,...Trifluoromethane/Chlorotrifluoromethane ($CHF_3/CClF_3$).....Light Blue*

* Colors are not governed by a nationally recognized standard. They may vary between manufacturers however; ICC regulations require that all cylinders be clearly labeled.

CHARACTERISTICS:

All of the refrigerants listed will exist in the cylinder in both liquid and vapor forms except those used to obtain extremely low temperatures. Those refrigerants are:

R-13.....Critical Temperature 83.9 ^{0}F.
R-14..... " " -50.2 "
R-503..... " " 67.1 "

The critical temperature is the temperature above which the substance cannot exist in the liquid state. Since these refrigerants produce extremely high pressures at or near their critical temperatures (in the 600-700 psig range) the cylinders present a considerable hazard to careless users. The less exotic refrigerants such as the remainder of those in the list also present significant hazards, and it is therefore necessary to exercise all safety precautions and all the rules for safe handling of compressed gases.

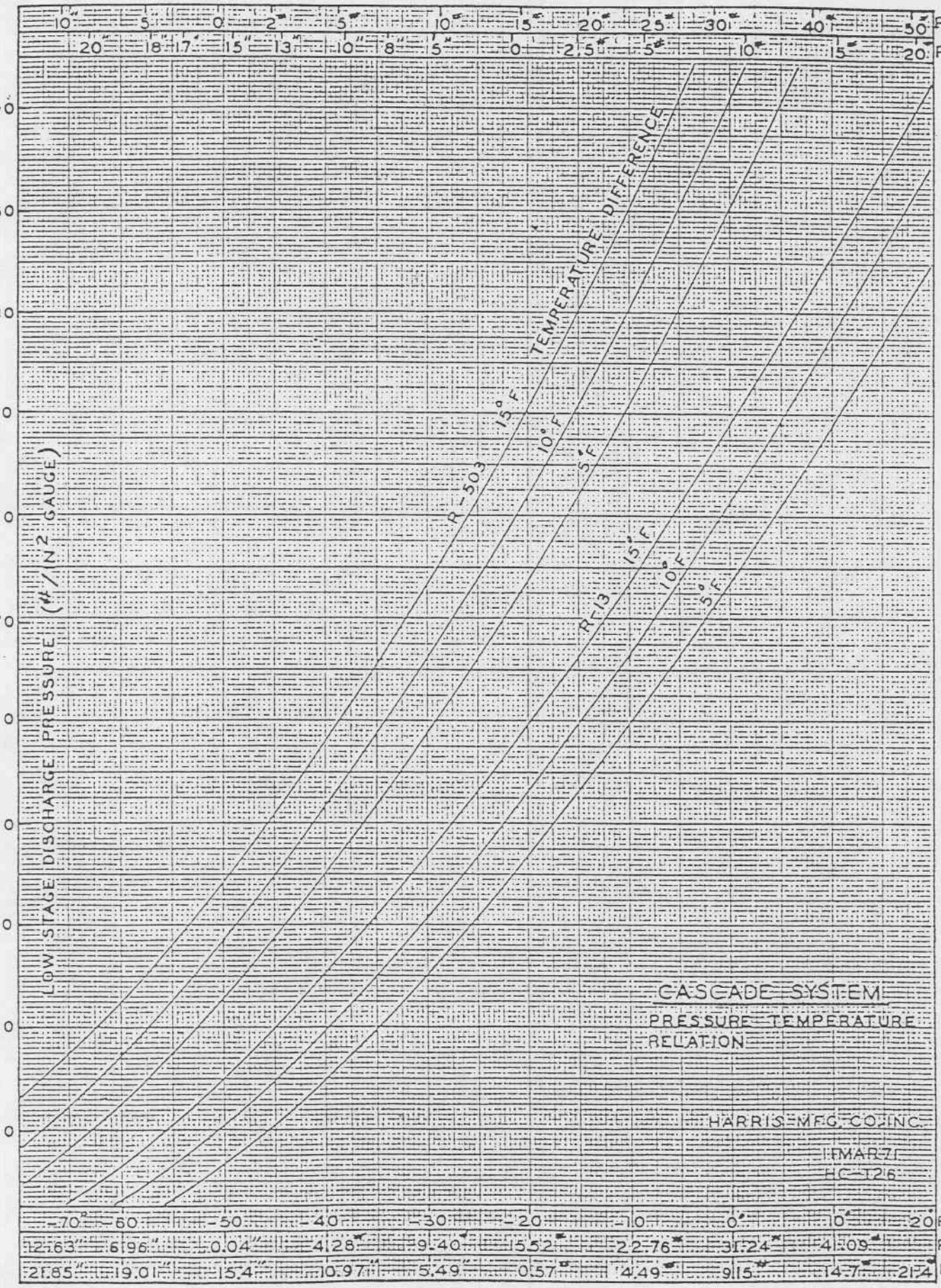


Figure 17...Refrigerant saturation curve

PRESSURE-TEMPERATURE RELATION OF CASCADE CONDENSERS

The pressure differential between the low stage compressor discharge and the high stage compressor suction, when converted to a saturated temperature differential, gives a reliable indication of the balance of the cascade system.

Normal operation of most cascade systems is with a temperature split between low stage condensing and high stage evaporating of between 5 and 15 ^{0}F.

Curve No. HC-126 (Figure 17) has been calibrated for temperature differences of 5^{0}, 10^{0}, and 15^{0}F for refrigerants R13 and R503 as low stage refrigerants, R12 and R502 as high stage refrigerants.

The operating split for a cascade system using a combination of these refrigerants may be determined as follows:

1. With accurate pressure gauges, determine the operating pressures of both the high and the low stage systems.

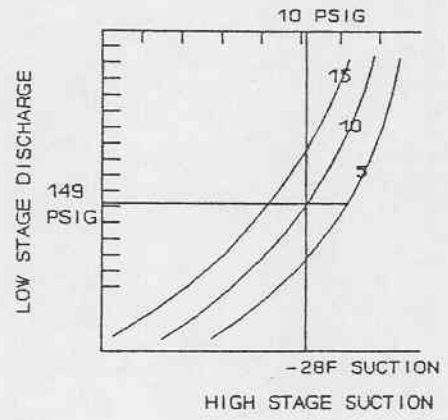
2. On figure 18, locate the pressure of the low stage discharge and read across to the corresponding refrigerant curve.

3. Locate the high stage suction pressure and read up or down to intersect the horizontal line.

4. The point of intersection will provide the operating split. If the intersection point is between or outside of the curves, some interpolation or extrapolation will be required.

Example:

Low stage discharge pressure = 149psig
High stage suction pressure = 10psig



Cascade temperature difference = 10^{0}F

SAFE HANDLING RULES FOR COMPRESSED GASES

1. Receiving. You must know your gases. Make sure the identification tag required by ICC regulations is in place. Even though cylinders are color coded they are sometimes filled with a gas other than that denoted by the cylinder color. The I.D. tag should always stay with the cylinder and the cylinder's protective screw-on cap must always be in place when the cylinder is not in service.

2. Moving. Always transport cylinders in an upright and supported position with the protective cap in place. If a cylinder is in a horizontal position and the valve is accidentally knocked off the cylinder becomes an unguided high speed missile. Avoid rolling or sliding cylinders even for a short distance. Use a suitable hand truck which carries the chained cylinder in an upright position.

3. Securing. Cylinders when stored at the point of use should always be chained in an upright position in order to prevent the above catastrophic result.

4. Storing. After cylinders are received and before being put in service they should be carefully stored. Secure them in an upright position out of the direct rays of the sun or away from steam pipes and other heat sources if inside. Keep from standing in damp locations where rust can affect the bottoms. Never store empties and full cylinders together. It is good practice to mark empty cylinders in bold letters as soon as they are exhausted to avoid the possibility of mixups. Never tamper with any of the safety devices on a cylinder. Avoid subjecting cylinders to any temperatures over 125 ^{0}F. This would dictate that storing or transporting any cylinders in a closed truck should be avoided.

5. Cylinder valves will vary in characteristics such as outlet type and safety device design. The Compressed Gas Association has adopted the various outlets so that regulators which can be used with a valve can also be used with a cylinder valve for a compatible gas. The American Standards Association has embraced this philosophy as well. The four basic types of valves provide ample choices to cover compatible groups. For this reason the use of adapters should always be avoided. The four basic types of safety devices built into cylinder valves are:

a. Safety relief. Usually used on low pressure liquefied flammable gases. These valves will relieve over pressure and then reseat.

b. Frangible disc ("Rupture disc") for high pressure cylinders. The entire cylinder contents will be discharged if this disc fractures. It is designed to burst considerably above the service design pressure of the cylinder but below the hydrostatic test pressure.

c. Frangible metal disc backed up with a fusible metal plug. This combination is used in high pressure cylinders and will function to release the entire contents of the cylinder only if the cylinder becomes hot enough to melt the fusible plug.

d. **Fusible metal plug.** Melts away at excessive temperatures allowing the entire contents of the cylinder to escape.

CAUTION: ALL OF THESE DEVICES WILL PREVENT CYLINDER BURSTING DUE TO OVER TEMPERATURE BUT ITEMS c. AND d. WILL NOT PROTECT AN OVERFILLED CYLINDER FROM BURSTING DUE TO TEMPERATURE WHICH IS NOT HIGH ENOUGH TO MELT THE FUSIBLE PLUG.

The modern "Throwaway" container presents some unique hazards. The low pressure refrigerants are being increasingly shipped in these containers since they are generally in small sizes and are very convenient to use. They should always be kept in their cardboard shipping cartons because there is no protective cap over the service valve which is generally only a Schrader (bicycle tire) valve. Also, since these are thin walled steel vessels, any contamination resulting from refilling or using as a service reservoir to hold a system charge renders them very dangerous. Some have, in the past, been used as emergency high pressure air reservoirs, a most hazardous practice and, due to corrosion from condensation inside the container, they have over time become weakened and burst with fatal results.

REGULATORS:

All compressed gas cylinders, with the exception of liquid CO_2 cylinders for standby refrigeration, containing pressures above approximately 350 psig at 75 ^{0}F. ambient should be equipped with a regulator to prevent destructive pressure rise in systems being serviced when cylinder valves are opened. An automatic pressure regulator equipped with two pressure gauges is the best and safest equipment but, a manual needle valve with pressure gauge to show the amount of cylinder pressure is acceptable when used with caution.

When using the high pressure gas-only cylinders such as nitrogen and oxygen remember that these gases cannot be liquefied and readily contained so instead, the gases are pumped into the cylinders to a very high pressure on the order of 3,000 psig. For this reason, even when equipped with automatic pressure regulators these cylinder hand valves should never be suddenly opened or else damage to gauges and regulators will result. Instead, the hand valve should be carefully cracked just off its seat and pressure be allowed to build up slowly behind the regulator. When the cylinder side gauge reading stops rising the valve can be opened fully with no damage to any components.
Do not confuse these high pressure cylinders with the Dewar flasks commonly used to ship liquid nitrogen, hydrogen, helium, etc. These are low pressure extremely well insulated containers very similar to a common "thermos bottle" but larger. The liquid is allowed to boil off very slowly as heat leaks through the walls of the flask. It follows that the liquid in this type of flask is extremely cold, about -320 ^{0}F. for liquid nitrogen.

When working with the aforementioned liquefied gases always wear protective clothing; most importantly a full face shield and gloves. Even though these liquids are cold they can produce severe injury much akin to burns and equally painful.

SECTION 700

MAINTENANCE AND SERVICE

SECTION 700

SERVICE TOOLS

The following suggested tools are the minimum required to adequately service cascade refrigeration systems. The manufacturer's names are for guidance only and do not constitute any endorsement of one manufacturer over another. Any "or equal" may be used for a listed item.

DESCRIPTION	CAT. NO.
1-VALVE STEM RATCHET WRENCH, 6 1/4 ", DURO	4491
1-TWO STAGE VACUUM PUMP, 2.2 CFM, ROBINAIR	15102A
1-GAUGE, ELECTRONIC VACUUM, ROBINAIR	14010
1-WRENCH SET, COMBINATION BOX/OPEN END SET, 3/8-1"	2230-11
1-TUBE CUTTER, IMPERIAL EASTMAN,	374FC
1-TUBE CUTTER, IMPERIAL EASTMAN, "IMP	127FB
1-REAMER, INSIDE/OUTSIDE, IMPERIAL EASTMAN	208F
1-FLARING & SWAGING TOOL, IMPERIAL EASTMAN	275FS
1-PINCH OFF TOOL, IMPERIAL EASTMAN	105FF
1-SOCKET SET, 1/4" DRIVE, 3/16-1/2", KLEIN	5500
1-SOCKET SET, 1/2" DRIVE, 5/8-1 1/4", KLEIN	65512
1-ALLEN KEY SET, 16 PIECES, ALLEN	666
1-MULTI TORCH CHEST, TURNER	HT99B
1-CLAMP-ON AMMETER, AMPROBE	RS2
1-GAUGE MANIFOLD, WITH GAUGES, HOSES AND HOOK, IMPERIAL	40202
1-DUAL RANGE, 4 LOCATION THERMOCOUPLE THERMOMETER, ANNIE	A-8
1-TOOL BOX, WATERLOO	WA50124B
1-ELECTRONIC LEAK DETECTOR, TIF MODEL	5500
1-6" ADJUSTABLE WRENCH, DIAMOND TOOLS	D76
1-8" ADJUSTABLE WRENCH, DIAMOND TOOLS	D78
1-10"ADJUSTABLE WRENCH, DIAMOND TOOLS	D710
1-6"LONG NOSE PLIERS, SIDE CUTTING, DIAMOND	SN56P
1-6"DIAGONAL CUTTING PLIERS, DIAMOND	S56
1-10" GROOVE JOINT PLIERS, DIAMOND	HL110P
1-SCREWDRIVER, 1/8" X 3 1/2, DIAMOND	V24C
1-SCREWDRIVER, 1/4" X 6", DIAMOND	V46
1-SCREWDRIVER, 3/8" X 8", DIAMOND	V68
1-SCREWDRIVER, 3/16" X 3" PHILLIPS, DIAMOND	V33P
1-SCREWDRIVER, 1/4" X 4", PHILLIPS, DIAMOND	V44P
1-SCREWDRIVER, 5/16" X 6", PHILLIPS, DIAMOND	V56P
1-3/16" NUT DRIVER, DIAMOND	6
1-1/4" NUT DRIVER, DIAMOND	8
1-5/16" NUT DRIVER, DIAMOND	10
1-11/32" NUT DRIVER, DIAMOND	11
1-3/8" NUT DRIVER, DIAMOND	12
1-7/16" NUT DRIVER, DIAMOND	14
1-1/2: NUT DRIVER, DIAMOND	16
1-REFRIGERANT TRANSFER COMPRESSOR, TECUMSEH PROD.	A1336A
1-CHANGOIL PUMP, THERMAL	17151
1-MULTIMETER, DIGITAL, JOHN FLUKE CO.	NA

TROUBLE SHOOTING GUIDE

STOP NOW IF YOU ARE NOT PROPERLY QUALIFIED TO SERVICE THE SYSTEM

Symptom	Possible Cause	Test and Correction
A. High Stage Compressor does not run.	1. No Power	1. Check power source. If none, call qualified electrician.
	2. Inoperative control	2. Jumper across contacts. If compressor starts but control is calling for closed contacts replace the control.
	3. Loose wiring at terminals.	3. Inspect all electrical connections.
	4. Inoperative compressor contactor	4. Start compressor using test cord or momentarily jumper contactor points. If compressor runs, replace the contactor.
	5. Inoperative overload.	5. Jumper all three overload terminals. If compressor runs, replace the overload.
	6. Low voltage.	6. Read supply voltage while unit is running. Reading must equal rated +/- 10%. If fluctuations are common add Voltage Safeguard, optional accessory.
	7. Open or grounded compressor windings	7. Disconnect compressor leads and read phase to phase ohms @ 2.38 and infinity for any terminal to ground.
	8. Stuck compressor.	8. If electrical checks are O.K. try to start by manually engaging contactor. Replace if inoperative.
B. Low Stage compressor does not run.	1. No Power	1. Check power supply. Refer problem to qualified electrician.
	2. Inoperative controller, reverse acting pressure, control, high pressure limit or circuit relay.	2. Check each component with high stage running and down to temperature. Replace defective control.
	3. Loose wiring at terminals.	3. Inspect all electrical connections, tighten as necessary.
	4. Inoperative compressor contactor.	4. See A-4 above.

	5. Inoperative overload.	5. See A-5 above.
	6. Low voltage.	6. See A-6 above.
B. Continued	7. Open or grounded compressor winding	7. See A-7 above.
	8. Stuck compressor	8. See A-8 above.
	1. Loss of refrigerant	1. Check for leak, repair, evacuate and recharge
	2. Compressor will not pump.	2. Install low side gauge. If running pressure is no lower than start pressure, replace compressor, evacuate and recharge system.
C. Unit runs but little or no refrigeration.	3. Restriction low stage.	3. Shut unit off and install low side gauge. If pressure equalizes from high side to low side (over 10 minutes) or no equalization occurs, try disabling the high stage compressor and allow the low stage head pressure to build up to 275 psig. A sudden rise in low stage suction pressure will indicate that the restriction has cleared. If it does not, allow the cabinet to warm up overnight and restart. If it still did not clear, the evaporator must be isolated and back-flushed.
	4. Inoperative high stage condenser fan.	4. Check for fan blade obstruction. Check fan motor and replace if necessary.
	1. Cold control set too low.	1. Check specifications for lowest design temperature. Reset control
	2. Inoperative control. Will not shut unit off.	2. Replace control
	Contacts stuck on one of relays.	Replace relay
D. Unit runs continuously	3. Wet insulation.	3. Replace freezer.
	4. System under charged.	4. Check operating pressures. If low shut down, warm up overnight and check soak pressure.
	5. System over charged.	5. Check operating pressures. If low, check wattage. Check low stage suction service valve for excessive frost and purge as

		necessary. High stage has a receiver for some excess charge. Purge until head pressure returns to normal.
	6. Non condensibles in system.	6. Check operating pressures and wattages. Wattage will be high and suction pressure low. Purge charge evacuate and recharge.
	7. Restriction	7. See item c-3 above
	8. Worn or inefficient compressor.	8. Check operating pressures and wattage. Front seat suction service valve. If compressor pulls 18 to 20" vacuum on gauge within 2-3 minutes, compressor is OK. Shut down compressor and observe suction gauge for buildup of pressure. Indicates bad discharge valves if rapid.
	9. Wrong refrigerant installed.	9. Check data plate for correct refrigerant, purge charge and recharge with correct refrig.
	10. Leaking needle valve in oil separator.	10. Oil return line will be warm. Discharge pressure will be lower than normal, suction higher than normal. Suction gauge may fluctuate. Replace oil separator
	11. One or more sub lids missing.	11. Replace missing sub lids.
	Poor gasket seal.	Replace lid gasket.
	12. Machine compartment fan not running	12. Check for fan blade obstruction and replace fan motor if inoperative.
E. Cabinet temperature colder than control setting.	1. Control out of calibration.	1. Recalibrate if necessary.
	2. Inoperative control.	2. Replace control if necessary.
	3. Cabinet relay or points fused.	3. Replace relay if necessary.
F. Frost buildup on breaker strip.	1. Gasket not sealing properly.	1. Gasket wrinkled, worn or torn. Check gasket retaining means and replace if necessary. Any frost will accumulate at the point of an air leak. Check gasket carefully in the area of any concentrated frost buildup.

PROCEDURES

I. The MBF500 refrigeration systems are factory charged with a correct charge of oil for the semi-hermetic compressors and correct refrigerant charges for both high and low refrigeration stages of the redundant refrigeration systems. Relatively little routine maintenance is required.

a. AIR COOLED CONDENSERS:

Because heavy traffic areas are dustier than others, a cleaning schedule for air cooled condensers and filters is difficult to predict. A suggested schedule however, is 6 months which can be adjusted as needed. Access to the filters is gained by removing the eight screws around the edges of both front louvered panels. The filter will pop out and can be washed with a mild detergent, rinsed and replaced. It is not necessary to dry the filter. The condenser coil itself may be vacuumed clean at the same time.

b. CHECKING COMPRESSOR OIL LEVEL:

Lubricating oil is retained in both the compressor crankcase and in passages below the motor rotor. It will not leave the compressor unless a serious refrigerant leak has occurred. Oil slingers at the motor end of the crankshaft pick up the oil and feed it to the crankshaft. Centrifugal force then delivers oil under pressure to the bearings, crank pins, etc. THE UNIT MUST BE LEVEL. If the compressor end is too low oil cannot reach the slingers. These compressors have a sight glass and the oil level should be visible in the upper half of the glass. Too much oil encroaches on the clearance space between the rotor and stator of the motor and should be avoided.

c. FAN MOTORS:

One or more cooling fans are provided in the machine compartment of Harris freezers, both water cooled and air cooled. No oiling is necessary. During periodic maintenance these fans should be checked for operation. If the compressors are running but any one of the fan motors is not, the inoperative one must be replaced.

d. DEFROSTING:

Chest type freezers do not require defrosting more often than once every six months to a year unless they are subject to heavy usage. Frost will begin to build at first around the top of the inner liner and will decrease in proportion to the distance from the top. "Snow" will be the most apparent accumulation and it may be removed with a plastic scraper. If any hard ice has developed, do not chip it using metallic objects. Instead, remove all products stored in the freezer and allow it to warm up. When temperature has risen far enough the ice can be readily dislodged.
To check gaskets for proper sealing, use a 2" x 6" piece of paper (a dollar bill is handy) closed between the gasket and the lid at 12" intervals around the perimeter of the lid. At each position
pull on the free end of the paper. A slight resistance should be felt. While performing this test, inspect the gasket for cuts or tears. An improperly

sealing gasket must be replaced.

II. CHECKING ELECTRICAL COMPONENTS

CAUTION!!! DANGEROUS VOLTAGES CAN EXIST ACROSS CAPACITOR TERMINALS. BE FAMILIAR WITH ELECTRICAL COMPONENTS AND THEIR TESTING IF YOU ARE GOING TO WORK ON THIS PORTION OF THE FREEZER.

a. CONTACTORS AND RELAYS

The two possible failure modes of contactors and control relays are 1, a burned out coil or 2, failed contact points. If the coil is burned out or electrically open, the device will not operate at all. If the points are burned out or failed mechanically, the relay will operate but, the circuit will not close. In the case of a 3 phase motor contactor with only one faulty contact the motor will attempt to start and may actually run if under light load but, it will be "single phasing" and will quickly trip the overloads.

b. COMPRESSOR MOTORS, THREE PHASE

The quickest way to check a compressor motor is through the use of an ohmmeter to obtain the resistances of the three field windings. First, disconnect all leads from the motor terminals. Second, set the meter at the lowest scale and read the ohms from T_1-T_2, T_1-T_3, and T_2-T_3 terminals. The readings should be close to the same (within +/-10%). If the variance is greater than 10%, carefully check the refrigerant gas for "burned" odor by shutting the unit off and attaching a gauge hose to the compressor discharge gauge port. Carefully crack the service valve from its back seat for one second and sniff the gas. If the gas smells clean the compressor is acceptable. Any burned odor signals a winding breakdown and a compressor change along with system cleanup is indicated. If not familiar with this procedure consult the factory.

COMPRESSOR MODEL NO.	RATED VOLTAGE	RATED LOAD AMPS (60hZ)	LOCKED ROTOR AMPS	WINDING RESISTANCE (OHMS)
				RUN
KAK1-0100-TAC	208VAC/3Ø/60Hz	3.3	25	2.38
KAL1-0100-TAC	220VAC/3Ø/50Hz	3.3	25	2.38

As part of the motor windings check, always read the resistance from windings to ground. It should be a high resistance, in the range of 100-130 megohms. Low readings indicate a beginning breakdown of the winding insulation. Readings that approach 1.0 to 2.0 megohms between any motor terminal to ground indicate that trouble is imminent. Some authorities use a hand cranked instrument called
a Megger to obtain these readings. There is an instrument available however, which gives more reliable readings than a Megger. This is the High Pot Tester. This meter gives a reading in milliamps reflecting the value of actual current leakage when a high potential is applied across windings to ground. Generally the tester is set up to deliver 1,000 volts plus twice the nameplate voltage rating for the motor. The current leakage should be 5 to 10 milliamps or less.

III. REFRIGERATION SYSTEM

a. PARTIAL OR COMPLETE LOSS OF REFRIGERATION

If both compressors are inoperative check to see if the unit's electric service connections have loosened. Also check the breakers, fuses or other overload devices in the power circuit. Next check to see if power is being interrupted by any safety controls, the thermostat, or operating printed circuit board. If the high stage has tripped out on the manual reset high pressure cutout, the condenser is dirty. If the low stage compressor is cycling on the automatic reset high pressure cutout, the high stage is not providing enough refrigeration for the cascade condenser and the trouble will be found in the high stage system. When cabinet temperature begins an unwanted rise, a shortage of refrigerant could be the cause. To check the charge in the low stage, empty the cabinet, disconnect all power and allow the cabinet to warm up for at least 8 hours with the lid open. This will assure warmup of the cascade condenser as well as the cabinet.

b. CHECKING REFRIGERANT CHARGE:

IMPORTANT: AT THIS POINT IN THE MAINTENANCE AND SERVICE WORK DO NOT PROCEED FURTHER UNLESS FAMILIAR WITH CASCADE REFRIGERATION SYSTEMS AND ARE QUALIFIED TO PERFORM SERVICE WORK THAT INVOLVES OPENING EITHER THE HIGH OR LOW STAGE SYSTEM TO THE ATMOSPHERE. THE DISCUSSION FOLLOWING MAY SEEM ELEMENTARY TO SOME EXPERIENCED REFRIGERATION TECHNICIANS HOWEVER, THE REVIEW OF CORRECT SERVICE PROCEDURES IS NEVER WASTED TIME.

c. SERVICE VALVES:

To check refrigerant charge, gain access to the system through use of the compressor service valves. The suction and discharge valves on the compressors are the three way type. They have both a back seat (stem turned all the way counterclockwise) and a front seat (stem turned all the way clockwise as viewed from the end of the stem). The back seat closes the 1/8"FPT gauge port but leaves the tubing connection open to the compressor. The front seat closes the tubing connection to the compressor but leaves the gauge port open to the compressor.

d. INSTALLING GAUGES:

<u>BEFORE INSTALLING OR REMOVING SUCTION SERVICE VALVE GAUGES ALWAYS SHUT DOWN THE COMPRESSOR AND WARM THE VALVE SO THAT MOISTURE WILL NOT BE DRAWN INTO A COMPRESSOR OPERATING IN A VACUUM. SEE BELOW.</u>

NOTE: When installing a gauge on the suction service valve of either compressor of a unit that is down to operating temperature, always assume that both systems are operating on a vacuum on the low or suction side. Shut down the system for two or three minutes to let suction pressure rise above a vacuum.

To install service gauges on the motor compressor service valves, remove the protective caps on the valve stems. The valves are shipped in the back seated condition from the factory. Attempt to back seat (turn stem counterclockwise) both valves. Remove the hex head 1/8" pipe plug from the service valves and install a 1/8"MPT x 1/4"Flare half union fitting in each one. Connect the service manifold hoses to these flare fittings and purge the hoses using a service cylinder of refrigerant of R-502 if working on the high stage, or R-503 if working on the low stage. Crack the compressor service valves off their back seats being sure that the manifold gauge valves are closed to prevent cross bleed of refrigerant from the discharge to the suction side of the system.

Read the pressures on the low stage system. For a warm cabinet, this is called "Soak Pressure or "Balanced Pressure." The low stage high and low side readings should be identical but, the two systems will read differently, not only because the refrigerants are different, but also because the high stage system pressures will not equalize since the refrigerant control device is a pressure limiting expansion valve and it shuts off tight when the evaporator pressure rises. In a 70°F. ambient temperature, the pressures will be as follows:

	HIGH STAGE (PSIG)	LOW STAGE (PSIG)
SUCTION	30	115
DISCHARGE	138	115

Since there is 4 lbs. of R-502 in the high stage system, the above pressures will stay the same even if a leak is present, until all of the liquid phase refrigerant has escaped, at which time it will fall below those values.

If the low stage pressure is lower than the tabulated value above, it indicates that a leak is present. If a leak is present in either stage it will have to be found and repaired, a high vacuum drawn on the system and a recharge of refrigerant added.

If a leak is suspected, see the following paragraphs on leak testing, evacuation and charging.

IV. LEAK TESTING, REPAIRING AND CHARGING

IMPORTANT:

THE FOLLOWING PROCEDURE ASSUMES THAT THERE HAS NOT BEEN A LOW SIDE LEAK WHICH HAS DRAWN AIR AND MOISTURE INTO THE SYSTEM. IF THIS HAS HAPPENED THE LOW STAGE WILL BE SHUT DOWN ON HIGH PRESSURE SAFETY OR THE PRESSURE READING ON THE LOW STAGE DISCHARGE GAUGE WILL BE UNUSUALLY HIGH OR IN EXCESS OF NORMAL PULLDOWN PRESSURES. THE PROCEDURE TO BE FOLLOWED IN THIS INSTANCE INVOLVES EVACUATION AND REFRIGERANT DRIER REPLACEMENT.

Install highside and lowside pressure gauges on both first and second stage systems. While gauges can be installed using a gauge manifold which allows the service technician much more flexibility in adding refrigerant and reading both pressures by merely manipulating the hand valves on the manifold, because the suction service valve on an operating compressor gets extremely cold the "O" ring in the manifold hose termination can change shape and there is a danger of drawing in moisture. It is recommended therefore, that a short length of copper tubing be used between the service valve and the flexible hose.

1. LEAK TESTING:

If it is impossible to find a leak with normal pressure present in the system it will be necessary to back up the pressure with dry nitrogen. The Nitrogen cylinder should be equipped with a pressure regulator and gauges. One gauge reads cylinder pressure and the other reads regulated pressure. When opening the main cylinder valve it must be done carefully to avoid ruining the gauges. Barely crack the main cylinder valve until the cylinder pressure gauge reading stops rising and then the valve may be opened a full turn. Connect the regulator outlet port to the system to be leak checked and set the regulator to 150 psig by rotating the regulator "T" handle clockwise until the outlet pressure gauge reads 150.

DO NOT PRESSURIZE THE SYSTEM OVER 350 PSIG UNDER ANY CIRCUMSTANCES.

The system is now ready to be leak checked. **NEVER, NEVER, NEVER!!!!** use **OXYGEN** for pressurization or any other purpose in a refrigeration system. This is a highly dangerous practice and will result in a violent explosion. No high pressure gas other than dry nitrogen is recommended as a pressure enhancer. Remember that there is now a mixture of nitrogen and refrigerant gas in the system. If the unit is restarted in this condition after leak checking is completed the operating pressures will be extremely high resulting in trip of the high pressure cutout. Be sure the system is evacuated and recharged by following the charging procedure outlined in this instruction. To test any Harris freezer for leaks an electronic leak detector is recommended. There are several on the market that are small enough to be easily portable such as the TIF model 5000. These will give an indication in the presence of very small amounts of refrigerant. Turn on the leak detector and when it is warmed up, set it for highest sensitivity. Move the probe slowly around each component and fitting until an audible signal is heard. Stop and decrease the sensitivity setting. Go back to the suspected leak site and attempt to pinpoint the exact location. It is easier to obtain a good fix with minimum reheating of a tubing joint if you know exactly where the fault lies.

2. REPAIRING LEAKS

Copper tubing joints are made using "Phos Copper" solder which is a high temperature brazing alloy needing no flux and with good working characteristics. Leaks in these joints are usually caused by pinholes in the joint and can be repaired by reheating the joint and adding extra brazing rod to the joint. It is not always necessary to add material so care should be exercised not to get too much brazing material into the joint.

Leaks occurring in components such as pressure controls or valves usually must be dealt with by replacing the offending component.
Whenever a system has been opened for repair it must be evacuated to a very low vacuum and the drier must be replaced. Always replace the drier with the same **BRAND AND SIZE** as originally supplied.

3. EVACUATION

No discussion on refrigeration service is possible without first recognizing a refrigeration system's worst enemy, air in the system. The entrance of air in the system would not be so troublesome if it were not for the fact that all air contains moisture. It is quite simple to purge air from a system but getting rid of moisture is quite another story. There has always been a tendency with technicians to open a system and not replace the drier after doing so.

THIS IS NOT GOOD PRACTICE AND MUST BE AVOIDED. THE COST OF A NEW DRIER IS EXTREMELY SMALL IN COMPARISON TO A REPLACEMENT COMPRESSOR OR LOSS OF PRODUCT.

THE VACUUM PUMP:
The service technician cannot function without a good vacuum pump capable of producing 50 microns of final pressure. This can also be expressed as the pressure exerted by a column of mercury .00004 inches in height. Since there is an atmospheric pressure at sea level equal to 759,968 microns it can be seen that a final vacuum requirement of 50 microns is very low. Since no gauge of the Bourdon tube type is capable of reading such an infinitesimal amount of pressure it is necessary to employ an electronic instrument commonly called a micron gauge similar to that manufactured by The Fredericks Company of Huntingdon Valley, Pennsylvania, under their description "Thermocouple Gauge", or the similar Robinair unit. This is an analog gauge and is connected to the remote sensor/filter assembly by a multi-conductor cable.

When evacuating a system there is an initial flow of gases and moisture toward the vacuum pump but, as the vacuum becomes deeper (after a minute or two) the molecules of contaminating elements do not move toward the pump except by their random motion. Eventually they work their way to the pump intake by bouncing off the walls of confining vessels and tubing and neighboring molecules. For this reason a means of speeding up the evacuation process called triple evacuation can be used to good advantage. To use this method the vacuum pump is connected to the suction service valve and the initial vacuum is pumped for approximately 10 minutes. The pump is valved off and allowed to remain running. The vacuum is broken by admitting dry refrigerant of the type to be used in the system at the discharge service valve and allowed to "soak" for one hour. The valve to the pump is then opened and the system evacuated again for 10 minutes. The pump is then again valved off and

the vacuum broken a second time, allowed to soak and again evacuated. This same procedure is followed one more time and the pump allowed to continue running until a final vacuum reading is obtained below 100 microns. The pump is now valved off and the micron gauge observed after 20 minutes. If the reading does not rise above 300 microns the system is considered adequately dry and evacuated of gaseous contaminants. If the reading rises above 300 microns there is either a leak or remaining contaminants. A leak can generally be ruled out at this point unless the leak is exceptionally small because the vacuum pump cannot keep ahead of a leak which could have been readily detected by a pressure test before the evacuation process was started.

Remember that the vacuum pump intake line should be kept as large as possible to facilitate the movement of contaminating molecules to the pump. A 3/8" O.D line is the recommended minimum size and the Imperial No. 620C service manifold mentioned in the service tools list has a 3/8" diameter vacuum path.

Vacuum pump oil should be changed **WHILE IT IS STILL HOT** and after each evacuation job because it becomes contaminated during the process of evacuation. If the pump oil is contaminated, it will be apparent that the pump is not capable of the good deep vacuum of which it was previously capable. Also, remember that moisture in the pump oil is a mortal enemy of the finely machined surfaces inside the pump and it will not long tolerate careless use. It is good practice to change the pump oil after each use, using the dry oil recommended by the pump manufacturer and the pump put away in a clean, dry condition ready for the next job.

4. CHARGING:

a. **HIGH STAGE.** The high stage of a cascade system is arranged and functions exactly like any conventional system with the single exception that the evaporator cannot be seen because it is part of the cascade condenser and is hidden in the foamed insulation. It is in intimate contact with the condenser of the low stage system. This high stage evaporator will operate at fairly low temperatures (-40 to -50F) and is therefore going to be at 0 psig or in a vacuum on the low side when down to operating temperature. First stages employ a liquid receiver and a thermostatic expansion valve. Because of this the system will be very forgiving of any extra refrigerant charge within reason. This means that an overcharge of 5 or 6 ounces will have no appreciable effect on performance since excess charge will only raise the liquid level in the receiver. Refrigerant should always be charged into the system in vapor form through the suction service valve. Add charge until the receiver is approximately 1/3 full. This can be determined by carefully heating the receiver and noting the line of demarcation between the warm part and the cool part of the receiver. Do not heat any more than necessary to feel warmth on your hand.

b. LOW STAGE:

The procedure for charging the low stage is more exacting than the high stage because a capillary tube flow control is used instead of a thermostatic expansion valve. With this arrangement the refrigerant charge will be less and the amount will be critical, there is less room for error in the amount charged and the pressure rise will be limited when the cabinet is allowed to warm up for at least 12 hours with the lid open. This value is the vapor balance pressure. The following procedure assumes that service work has been

done on the low stage requiring that a high vacuum has been drawn and now exists in the low stage system. First, break the vacuum with instrument grade propane to a gauge pressure of 15 psig. Attach a needle valve and gauge to the R-503 cylinder for the low stage. Connect the cylinder to the suction service valve port, purge the connecting tube and then admit R-503 until the pressure reads 140 psig. Remove all service fittings, replace pipe plugs, flare caps and valve stem caps.

OPERATION DATA

System A (SAMPLE) DATE ..../..../....

UNIT MODEL NO. ....MBF-500.. TYPE ..... SERIAL NO. .....

POWER VOLTS .208/230. PHASE ..3..... HERTZ 50/50.. AMPS .10 each, 20amps Total

CONTROL VOLTS ..208/230

		HIGH STAGE	LOW STAGE
COMPRESSOR		Copeland	Copeland
MODEL		KAK1-0100-TAC	KAK1-0100-TAC
SERIAL NO.			
REFRIGERANT		R-502	R-503
WEIGHT or		40 oz.	
VAPOR BALANCE PRESSURE			120 psig
OIL CHARGE	COMPRESSOR	24 oz.	24 oz.
	SEPARATOR		15 oz.

	CUT OUT	CUT IN	CUT OUT	CUT IN
HIGH PRESSURE CONTROL	400#	Manual	300#	180#
LOW PRESSURE CONTROL				
REV. ACT. LOW PRES. CONTROL	20#	5#		
CPR SETTING			6 psig	
T X VALVE / CAPILLARY TUBE	FR-1/8-ZP		20' of .065	

OPERATING CONDITIONS

	PULL DOWN	LOW TEMP*	PULL DOWN	LOW TEMP*
DISCHARGE PRESSURE	180#	155#	166#	81#
SUCTION PRESSURE	8#	4"	4#	15"
MOTOR AMPERAGE	3.7	3.3	3.0	2.6
RATED F L MOTOR AMPS	3.3	3.3	3.3	3.3

PULL DOWN: AT APPROX. .30..MIN. AFTER START

*LOW TEMPERATURE ..-94.6..°C AIR; .....°... WALL

CHAMBER FAN (IF SUPPLIED) RATED FLA ..... ACTUAL .....

FUSES; PRIM. GMQ 3.2 SEC. .....

MULLION ..... C'CASE HEATER ..... COMP. .....

REMARKS:

TXV 1 1/4 turns open from closed position
second stage charged with 3 oz. pentane
bypass switches set to cycle auxillary
temp. control set at -82 C recorder calibrated at
-94.6 C alarm and remote alarm teminals check
OK.

HMC-129-1

OPERATION DATA
(SAMPLE)

System B DATE ..../..../....

UNIT MODEL NO. MBF-500 TYPE ..... SERIAL NO. .....

POWER VOLTS 208/230 PHASE 3 HERTZ 50/60 AMPS 10 each, 20amps Total

CONTROL VOLTS 208/230

		HIGH STAGE	LOW STAGE
COMPRESSOR		Copeland	Copeland
MODEL		KAK1-0100-TAC	KAK1-0100-TAC
SERIAL NO.			
REFRIGERANT		R-502	R-503
WEIGHT or		40 oz.	
VAPOR BALANCE PRESSURE			120 psig
OIL CHARGE	COMPRESSOR	24 oz.	24 oz.
	SEPARATOR		15 oz.

	HIGH STAGE		LOW STAGE	
	CUT OUT	CUT IN	CUT OUT	CUT IN
HIGH PRESSURE CONTROL	400#	Manual	300#	180#
LOW PRESSURE CONTROL				
REV. ACT. LOW PRES. CONTROL	20#	5#		
CPR SETTING			6 psig	
T X VALVE / CAPILLARY TUBE	FR-1/8-ZP		20' of .065	

OPERATING CONDITIONS

	HIGH STAGE		LOW STAGE	
	PULL DOWN	LOW TEMP*	PULL DOWN	LOW TEMP*
DISCHARGE PRESSURE	170#	147#	165#	81#
SUCTION PRESSURE	7#	4"	4#	15"
MOTOR AMPERAGE	3.7	3.3	3.1	2.6
RATED F L MOTOR AMPS	3.3	3.3	3.3	3.3

PULL DOWN: AT APPROX. 30 MIN. AFTER START

*LOW TEMPERATURE -94.6 °C. AIR; ..... °... WALL

CHAMBER FAN (IF SUPPLIED) RATED FLA ..... ACTUAL .....

FUSES; PRIM. GMQ 3.2 SEC. .....

MULLION ..... C'CASE HEATER ..... COMP. .....

REMARKS: TXV 1 1/4 turns open from closed position
second stage charged with 3 oz. pentane.

HMC-129-1

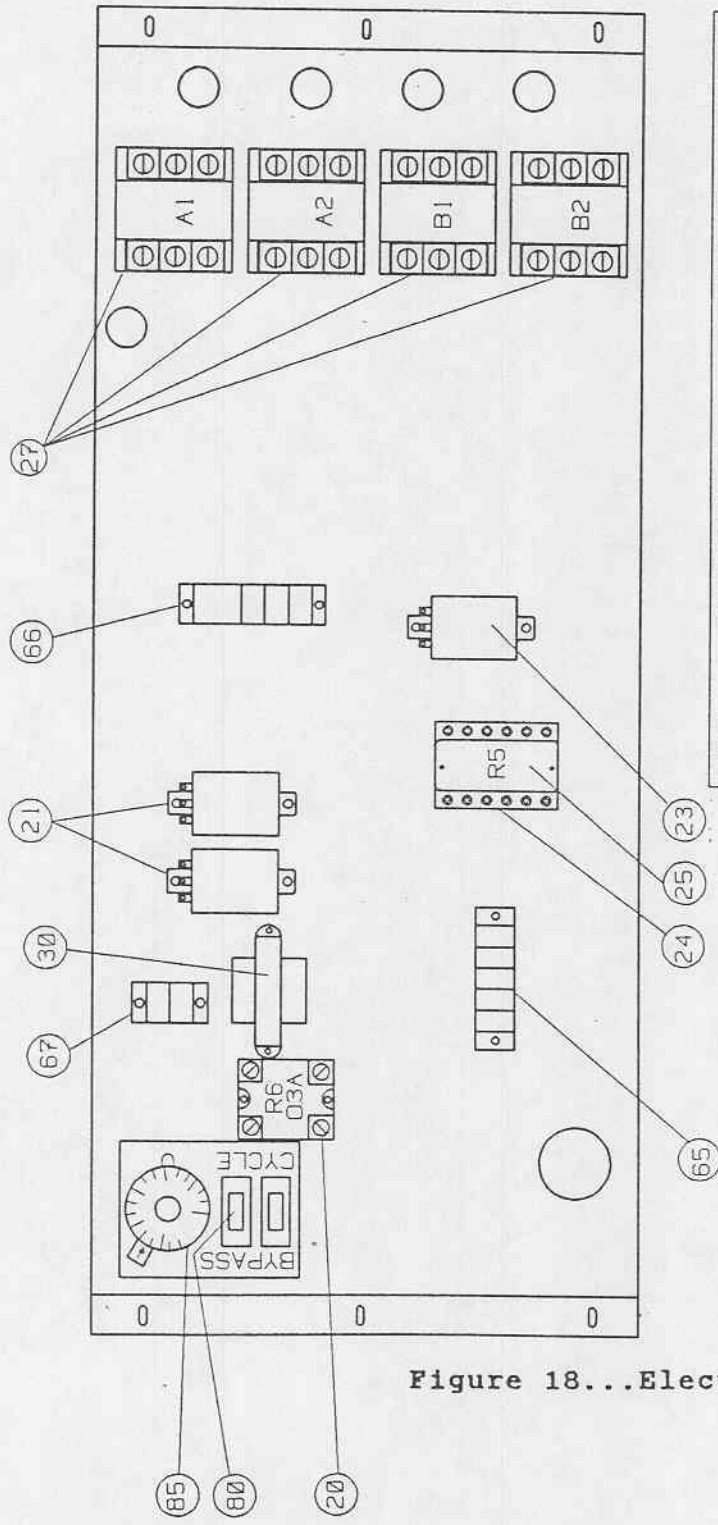
SECTION 800.

SERVICE PARTS

SERVICE PARTS
MBF500 DUAL REFRIGERATION

Part Number	Ref. No.	DESCRIPTION	QUANTITY
C69926H01		PANEL, INDICATOR	1
C63652H19		FCU 404 W/O 0.1 DISPLAY,(0.2°C. Hysteresis)	1
S69070H02		SWITCH, KEY	2
S63648H01		SWITCH, PUSHBUTTON, SPDT	3
S63736HO3		POTENTIOMETER, 10 TURN	3
C80337G01		AUX STATUS INDICATOR ASS'Y	1
D46433H07	29	U.E. 650 SKELETON RECORDER	1
P90588H07		RECORDER MOTOR, 230VAC/60Hz, U.E.6"	1
N90588H08		RECORDER MOTOR, 220VAC/50Hz, U.E.6"	1
B90520G07		CHART, RECORDER	1
C63017H09		GASKET, INNER	1
C63018H09		GASKET, OUTER	1
P49224H09	26	VALVE, FR 1/8-ZP	2
M75455H01	15	INTERSTAGE Y/P HEHS-003-9	2
S47417H33	27	CAPILLARY, .065"ID X 240"	2
M75380H01	24	DRIER, SPORLAN, #C-032S	4
S63647H01	40	RELAY, SOLID STATE, 0.3 AMP	1
S44569H06	44	RELAY, 3PDT, 12VAC	2
A44569H07	41	RELAY, 3PDT, 240V coil	2
B26646H01	43	RELAY, SEQUENCING, SOLID STATE, 240VAC/60HZ	1
M75900H01		SOCKET, RELAY	1
M75483H01		CONTACTOR 3P/230VAC/30Amp	4
S41026H62		TRANSFORMER, 208/240VAC-12VAC	1
B45829H01		CONTROL, TEMPERATURE	1
C61833H01		HINGE ASSY	5
A88580H01		WIRING DIAGRAM, CONTROL	2
C85214H01	12	CONDENSER, SYSTEM A	1
C85214H02	12	CONDENSER, SYSTEM B	1
A81475H01	21	OIL SEPARATOR, TEMPRITE	2
A68762H01	30	VALVE, PRESSURE RELIEF	2
B45826H01	32	CONTROL, HIGH PRESS. CUTOUT 275/120, LOW STAGE	2
B48575H03	32	CONTROL, HIGH PRESS. CUTOUT MAN RESET, HI STAGE	2
S75462H01	34	CONTROL, REVERSE ACTING L.P., P70CA-117	2
S69949H20		COMPRESSOR, KAK1-0100-TAC 208-230VAC/3Ø/60Hz	4
B5433 H01	67	MOTOR, FAN, 14 WATT, 230VAC/1Ø/60Hz	2
S4503 H04		BLADE, FAN, 10", 4 BLADE, 32° PITCH	2
B61669H01	66	MOTOR, FAN, 35 WATT, 230VAC/1Ø/50-60Hz	2
M93710G02		SENSOR, FREEZER SERVICE ASSEMBLY	1
A69156H02	25	FUSE, 3.2A/250VAC	2
A64151H02	7	SWITCH, SPDT (SW-1, SW-2)	1
A64151H01	7A	SWITCH, SPST	1
S49200H01	10	LIGHT, AMBER INDICATOR	2
S49200H02	10A	LIGHT, RED INDICATOR	1

Note: Reference numbers appear on drawing B23625, Flow Diagram, page 35 and on B85240, Wiring Diagram, page 37.

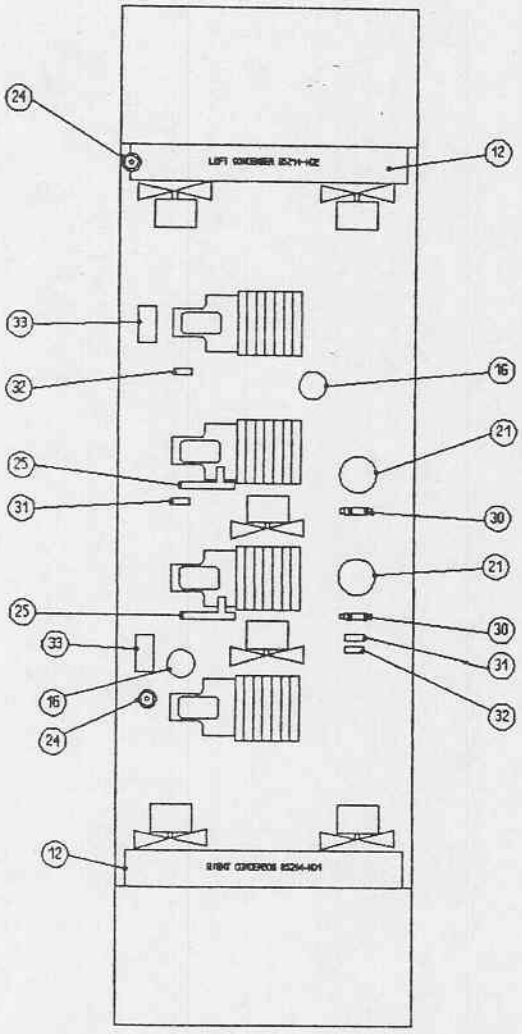


ITEM	DESCRIPTION	PART NO.	QUANTITY
20	RELAY,SOLID STATE,Ø.3A	S63647H01	1
21	RELAY,3PDT 12VAC	S44569H01	2
23	RELAY,3PDT 240VAC	S44569H07	1
24	SOCKET,RELAY	M75900H01	1
25	RELAY,SEQUENCING,SS	B26646H01	1
27	CONTACTOR, A-H	N80504H01	4
30	TRANSFORMER	S40126H62	1
65	TERMINAL STRIP	S81366H01	1
66	TERMINAL STRIP	S81684H01	1
67	TERMINAL STRIP	B3602H01	1
80	SWITCH,3POS,SPDT	A64151H02	2
85	CONTROL,TEMP	B45829H01	1

COMPONENT MTG. LAYOUT
JUNCTION BOX-HBF 500/700

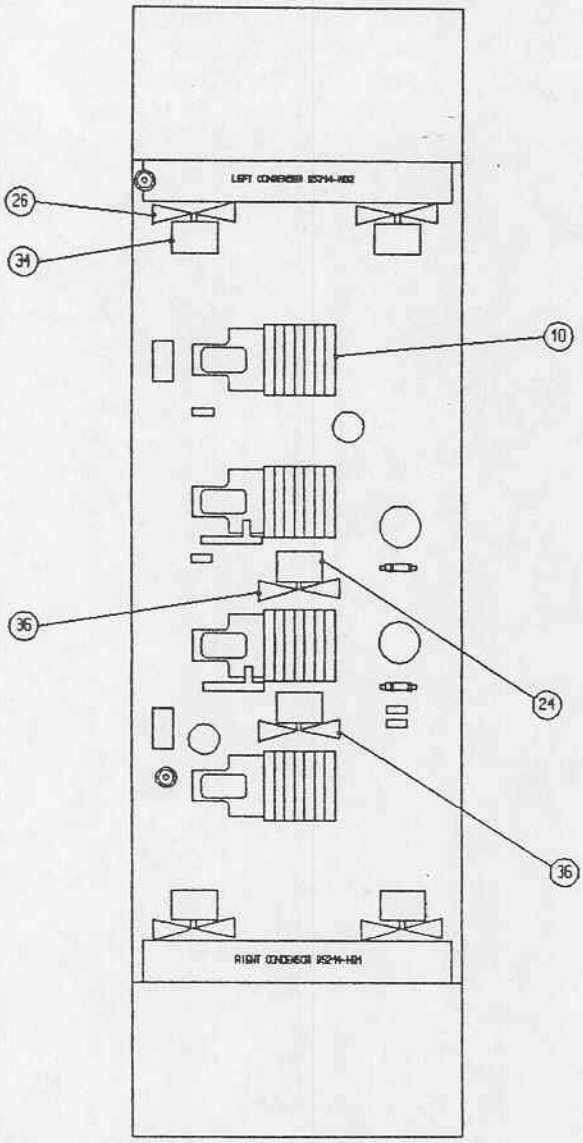
C84626

Figure 18...Electrical Junction Box Layout



ITEM	DESCRIPTION	PART NO.	QTY. REQ'D
3	REFRIGERANT , R502 (NOT SHOWN)	S47303H08	8 LBS.
4	REFRIGERANT , R503 (NOT SHOWN)	S47303H08	3 LBS.
5	PENTANE (NOT SHOWN)	W76739H01	6 OZ.
6	OIL , ZEROL 150 (NOT SHOWN)	S46205H02	126 OZ.
12	CONDENSER , AIR COOLED 12 X 23-39-38/144-R CONDENSER , AIR COOLED 12 X 23-39-38/144-L	N85214H01 N85214H02	1 1
16	RECEIVER , REF. RES #2030	N88945H01	2
21	OIL SEPARATOR , TEMPRITE	A81475H01	2
24	DRIER , SPORLAN C032S	W75360H01	2
25	CPR VALVE , SPORLAN CPOT	S49232H01	2
30	VALVE , PRESS RELIEF , HENRY	A68762H01	2
31	CONTROL , PRESS JOHNSON CONTROLS	N81478H01	2
32	CONTROL , PRESS " " MANUAL RESET , HP.	B48575H03	2
33	CONTROL , " REV. ACTING LOW PRESS. P70CA-117	S75462H01	2
57	ARMAFLEX INSULATION (NOT SHOWN)	W75933H01	24 FT.

Figure 19...Refrigeration deck layout



ITEM	DESCRIPTION	PART NO.	QTY. REQ'D
10	COMPRESSOR KAK1-0100	S69949H20	4
24	MOTOR , FAN 14W 230VAC/1PH/60HZ	B5433H01	2
26	BLADE , FAN	S4503H04	4
36	BLADE , FAN	N6S288H01	2
34	MOTOR , FAN 230VAC	S61699H01	4

Fig.20

SECTION II

ELECTRONICS SERVICE

NOTE: The information in this section is intended for use by a qualified Electronics Technician.

Control Calibration:

I. Required equipment:

A. Digital volt meter (DVM)

B. Celsius thermometer capable of measuring the operating temperature of the freezer at +/-0.1°C accuracy.

C. A custom decade box with one each of the following fixed value resistors (1/8 watt or greater, +/-0.1% tolerance, 10 parts per million (PPM) temperature coefficient, any composition):

1. 35.5 ohm
2. 88.2 ohm

NOTE: Individual resistors may be used in lieu of the decade box.

D. Screwdriver with 1/8" wide flat blade.

II. Calibration setup:

A. Turn cabinet power switch OFF.

B. Disconnect main power to cabinet.

C. Remove the screws holding the control panel in place.

D. Remove the screws which hold the control board to the control panel.

E. Carefully place the control board in such a position that the component side (side opposite 7-segment display) is accessible and all conductive points on the control board are insulated from shorting.

F. Remove the sensor leads from the control board screw terminal positions #25 and #28.

G. Connect decade box leads to screw terminal positions #25 and #28.

H. Set DVM to measure VDC (less than 10 volts). Connect negative lead (-) of DVM to screw terminal position #3 and positive lead (+) to screw terminal position #27.

I. Remove RTV sealing compound from potentiometers R-64, R-65, and R-67. (See figure .....)

III. Basic Calibration Procedure:

A. Apply main power to cabinet.

B. Turn power compressor key switch ON.

C Press the scan button on the control panel to select control set point adjustment.

D. Adjust control set point potentiometer on the control panel until DVM reads 1.00 volts.

E. Adjust potentiometer R-67 on the control board so that the control board display reads -100.0.

F. Set scan switch to display cabinet temperature.

G. Set decade box to 88.2 ohms and adjust control board potentiometer R-64 until display reads -30.0 (tolerance +/-0.1).

H. Set decade box to 35.5 ohms and adjust control board potentiometer R-65 until the display reads -160.0. (tolerance +/-0.1)

I. Alternate between steps G & H until desired readings are achieved.

J. Seal potentiometers R-64 and R-67 with RTV compound.
K. Basic calibration is complete. Remove DVM leads from the screw terminals. Remove decade box leads from screw terminals #25 and #28 and replace sensor input leads in their respective positions on the screw terminals.

IV. Cabinet Center Air Offset Calibration:

A. Place temperature measuring device such as a thermocouple in the freezer at the approximate geometric center.
B. Allow the freezer temperature to pull down to the control set point temperature.
C. Read the temperature of the added temperature measuring device just as the compressors cycle OFF.
D. With the freezer control set to display cabinet air temperature, adjust control board potentiometer R-65 until the control display matches the added sensor temperature.
E. Calibration is now complete. Turn compressor key switch OFF and remove power from the freezer.
F. Remount the control board to the control panel and the control panel to the cabinet.

THEORY OF OPERATION
404J CONTROLLER BOARD

Circuit operation of the 404J freezer-refrigeration controller circuit board is described in the paragraphs below. The description follows the general order presented in the system block diagram (Figure 22).

POWER SUPPLY (Figure 22 & Figure 23)
The 404J control board operates on 12 VAC supplied by a Class II step-down transformer. The power supply portion of the circuit card supplied charging current for the 12 V gelled electrolyte back-up battery, unregulated DC for relay coil operation, +5 VDC for sensitive analog circuits. +5 VDC for digital circuits and LEDs, and -5 VDC for the analog-to-digital (A/D) converter (7137). Additionally, a simple voltage measurement circuit detects failed line power conditions. These circuits are discussed in detail.

Rectifier/Filter Power to operate the control board is applied to terminals 1 and 2. Over current protection is provided by fuse F1. This prevents damage to the step-down transformer in the event of circuit malfunction. Protection against incoming voltage spikes is provided by a metal oxide varistor. Incoming AC from the stepdown transformer is rectified by a diode bridge D9 and filtered by capacitor C30. Filtered DC passes through D13 to terminal 5, through the front-panel key-switch, then returns to terminal 6 where unregulated DC is delivered to the +5 VDC regulators and the relay coils.

Battery The battery, a 12V rechargeable gelled-electrolyte, lead-acid type, supplies power to the board upon loss of AC line power. This keeps the alarm and display circuits active. The battery is charged through resistor R70, which acts as current limited for under-charge conditions and trickle-charge otherwise. Diode D15 allows battery current to flow to the circuit board when the unregulated voltage falls below battery voltage. The battery is fused to prevent fire should abnormal battery or circuit board conditions develop.

Low-Voltage Detector Line power is monitored by a simple threshold detector. CMOS invertor U6d monitors the unregulated supply voltage through a voltage divider consisting of R68 & R69. Diode D13 prevents battery voltage from mistakenly activating the voltage detector. An unregulated DC voltage below about 5 VDC will be identified as a loss of power condition.

Analog +5 VDC Regulator Analog circuits are powered by low-current +5 volt regulator U15. This +5 volt circuit (Va) is separate from the +5 volt logic and LED circuit. This ensures a stable, noise-free supply.

Digital +5 VDC Regulator Digital logic circuits (Vd) and display and discrete LEDs (V1) as well as +5 volts to off-board circuits are supplied by regulator U14, which is equipped with a finned heat sink. The +5 VDC for outside-of-board use is fused. Additionally, a metal-oxide varistor and inductor provide protection form external noise sources.

-5 VDC Charge Pump U11 supplies -5 VDC to the A/D converter and display driver chip by charge pumping action as follows: First, C10 is charged to +5 volts form Vd. Next, by internal action of U11, C10 is inverted and its charge is given to C11. This action is repeated at a high rate, which develops -5 VDC across C11. Although unregulated, this voltage is sufficient for U12's operation.

RTD AMPLIFIER (Figure 22)
A platinum RTD (100 Ohms at 0 C) is used to measure internal cabinet temperature. The low resistance of the RTD must be converted into a voltage suitable for the alarm, compressor control, and A/D converter circuits.

Amplifier/Filter The RTD forms one leg of a bridge circuit consisting of R6, R7, and R10. The gain and offset of the bridge circuit is adjusted by potentiometer R65 and R64, respectively. The bridge develops a differential voltage as the RTD's resistance varies with its absolute temperature. This differential voltage is amplified by the high impedance differential op-amp. The amplifier's frequency response is rolled off by feedback capacitor C6 to reduce the noise content of the signal. Components C7, C8, and R14 add further stability and noise immunity.

Recorder Output A buffered output (U2c) is provided for driving chart recorders. This voltage is taken form the output of U1c.

COMPRESSOR CONTROL (Figure 22 & Figure 24)

Measured cabinet temperature (via the RTD probe) is compared with a user selected set point to from a bang-bang error signal. This is used to determine when the compressors should be actuated. A six-minute lock-out timer prevents rapid cycling of the compressors.

Set Point Input The desired cabinet temperature is adjusted by the user through a frontpanel multi-turn potentiometer. Resistors R1 and R5 limit the maximum and minimum selectable temperatures. The potentiometer's wiper voltage is filtered by R4 and C3 then buffered by unity-gain amplifier U1d. The buffer amplifier's output is routed to the compressor control comparitor and to the display selector.

Control Comparitor A voltage comparitor is formed from U2d. Positive feedback creates hysteresis that separates the turn-off temperatures. This helps prevent frequent cycling and relay chatter. The hysteresis is adjustable by R66.

Control Timer U6a, U6c, U7a & b, and U9 form a lock-out timer. Once the compressor is turned off, this circuit prevents restart for about six minutes. Operation is as follows: With the compressor running, the logic state of U6a pin 1 is low; U6c pin 5 is high; and U2d pin 14 is low. The reset (pin 12) of counter-timer U9 is high, thus the counter is halted. When cabinet temperature set point is met the comparitor (U2d pin 14) goes high which turns off the compressor. The high-going signal on pin 14, pulse-formed by C18 and R24, sets flip-flop U7a, which holds off compressor operation. The counter-timer is released to operate as U7b pin 1 becomes logic low. The hold-off condition continues until U9 pin 3 goes high (about six minutes), which resets the flip-flop at U7a. In this condition, the compressor will operate when the comparitor's output goes low, indicating a cabinet temperature above set point.

Control Relay A pilot-level relay (1 amp contact rating) is operated by the control timer circuit. Relay drive is provided by sinking Vr through Q4. Flyback on the relay coil is shorted by D6, C28, and R34. R34 also lowers Vr slightly to prevent overheating of the relay coil at full line power conditions. The relay contacts are configured to be normally closed with coil in de-energized state.

ALARM CONTROL (Figure 22 & Figure 24)

Measured cabinet temperature (from the RTD probe) is compared with high temperature and low temperature alarm set point. The set points are user adjustable form the front panel potentiometer. Alarm conditions are locally sounded by a solid-state audio alert. Additionally, a set of Form C relay contacts are made to charge state. These may be used to remotely indicate alarm conditions. The alarm reset input to the board temporarily resets the audio alarm circuit for about five minutes; audio alarm continues to sound after the five minute period if the alarm condition persists.

Set Point Inputs Upper and lower alarm temperatures are adjusted by front-panel multiturn potentiometer. The potentiometer's wiper voltage are filtered by resistors and capacitors then buffered by unity-gain amplifiers U1a and U1b. The buffer amplifier's output is routed to the alarm comparitors and to the display selector.

Alarm Comparitors The upper and lower alarm voltages are compared with the MEASURED temperature voltage. The results of each comparison are combined to form a single temperature alarm signal. This logic signal is used to drive an alarm LED and to activate the alarm timer circuit.

Alarm Timer and Control Temperature alarm and low voltage alarm signals are combined at U8d. This signal is used to drive the alarm relay (through an NPN transistor) and to activate a resectable timer circuit. U10, U7c & d. U8a, & b. U6b. U6e and U6f comprise the time circuit. Operation is as follows: An alarm condition sets flip-flop U7d, causing operation of the sonic device. If the clear input is given a logic high, the flip-flop is reset and the counter at U10 is started. When the counter goes high on pin 3 (above five minutes), the flip-flop is once again set and the sonic device is reactivated. Should the alarm condition cease, the sonic device is deactivated. Flip-Flop U7c keeps cycling of the counter from deactivating the sonic device during alarm conditions unless the clear pushbutton is operated.

Alarm Outputs Alarm conditions are indicated locally by a solid-state sonic device and Remotely by Form display contacts. The sonic device is supplied by +5 VDC. Its activation is accomplished by sinking its current though an NPN transistor. The relay is supplied by Vr. Its activation is also by an NPN transistor. The relay contacts are protected by both 0.1 microfarad capacitors and by metal-oxide varistors. A maximum of 24 VAC should be applied to these contacts.

DISPLAY (Figure 22 & Figure 24)

Display of the temperature is made through three 7-segment LED digits. The value display is selectable from either current cabinet temperature, compressor control set point, upper alarm limit, or lower alarm limit. Selection is made by a scan signal. Each time a logic high is given to the scan input, the display is cycled to the next temperature signal.

Display Selection The display selector consists of a four-channel multiplexer, U3, a decade counter, U4, and a driver (U5) to sink the appropriate indicator LEDs. Each time a +5 volt signal is applied to U4 pin 14 (scan input) the counter steps to the next output. The fifth output resets the counter to limit it to one of four outputs high a time. Only one of four multiplexers passes a temperature voltage to the A/D converter chip, U12. Capacitor C23 ensures that the selector goes to the cabinet temperature on initial power-up.

A/D Converter and Display The A/D converter and display driver are contained in one chip, U12. The A/D converter uses a dual-slop conversion technique. The input on pin 31 is taken from the input selector circuit and compared against a reference voltage on pin 36. Specific component are as follows: C13 is the reference capacitor; C15, C16, and R19 are the integration network components; and C14 and R18 are the oscillator components. The LED display is supplied by VI. Each display segment is illuminated when U12 sinks that segment's current to ground. Current for each segment is internally regulated by U12 so that no limit resistor is required.

Reference Reference voltage is supplied to the A/D converter by D2, a 2.5 volt monolithic regulator. The voltage is trimmed by R67 to ensure accuracy of the display.

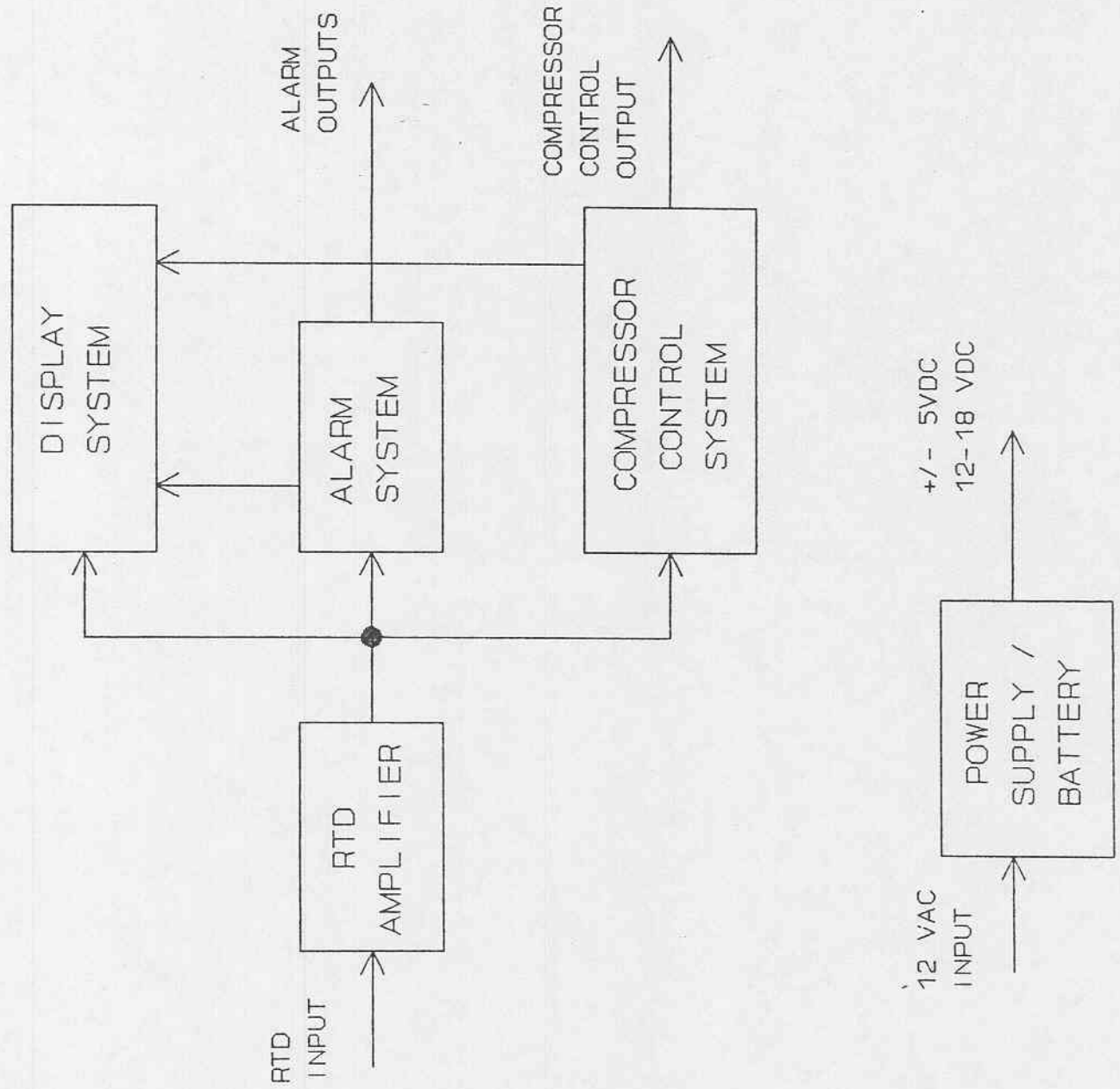
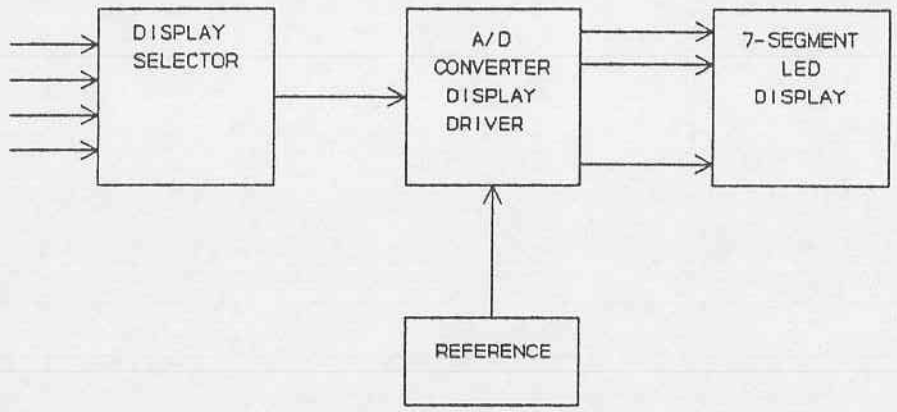
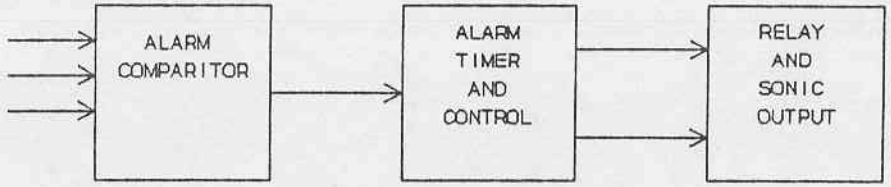


Figure 21...Sysytem block diagram

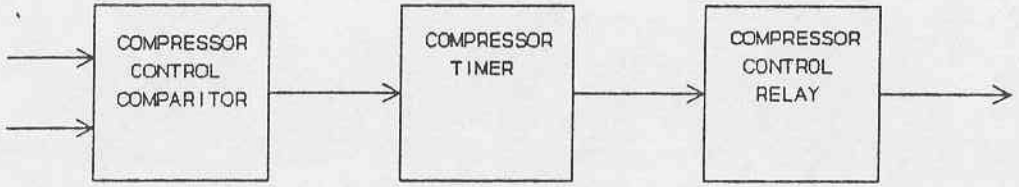
Figure 22...Power supply block diagram



DISPLAY SYSTEM



ALARM SYSTEM



COMPRESSOR CONTROL SYSTEM

Figure 23...Block diagrams

TROUBLESHOOTING GUIDE

CONTROL BOARD 63652H15

I. If the control board is suspected of being defective, for any reason, the following checks should be carried out prior to performing component level diagnostics on the board.

A. Verify that the main power is supplied to the freezer.
B. Verify the integrity of the wiring connections at the 30-pin screw terminal on the control board (main power and key switch OFF.
C. Verify the integrity of the 30-pin terminal interconnection at the control board (main power and key switch OFF.

II. SYMPTOM	PROBABLE CAUSE	TEST & CORRECTION
A. No display	1. No 12VAC at control board.	1. Verify that 12VAC is present at terminals 1 & 2 on the control board connector. If not, check power source at transformer (key#12, Fig.15).
	2. No 12VDC unreg. at control board.	2. Check for 12VDC on control board terminal #3(-) and #4(+). If not present check fuses F1, F2, & rectifier D9. Check for 12VDC #3(-) & #6(+). If not present, check key switch (Figure 16).
	3. No 5VDC regulated at control board.	3. Check for 5VDC at board terminal #3(-) & #26(+). If not present, check fuse F3 and regulators U14 & U15.
B. Display segment missing.	1. Defective display or U12.	1. Verify proper output of U12.
C. Displayed temperature does not match freezer temperature	1. Needs calibration	1. Recalibrate per specified procedure.
	2. Defective sensor.	2. Check sensor wiring & RTD resistance (100 ohms @ 0°C).
D. No scan function	Defective wiring	Check wiring connections between board & control panel.
	2. Defective control board component	2. Check components U3,U4, U5, & related discrete components on board.
	3. Defective scan switch	Short across scan switch connection points. If scan occurs, replace switch.

E. Set point pots will not adjust properly.	1. Defective wiring	1. Check wiring between between control board & panel.
	2. Defective board component.	2. Check U1, U2, U3, & related discretes.
F. No audio silence	1. Defective wiring	1. Check wiring between control board & panel.
	2. Defective audio silence switch.	2. With freezer in alarm, short across audio silence switch connections. If silences, replace switch.
	3. Defective board	3. Check components U6, U7, U8, U10, & related discretes.
G. Compressor will not cycle OFF	1. Defective board component.	1. Remove compressor control relay wire from terminal #10. If compressor does not stop, problem is not board related. If compressor stops, check relay CR2 and work back through C22, Q4, U6, U7, U9, U2, U1, & related discretes.
H. No audio alarm at power fail or temperature fail	1. Defective wiring	1. Check wiring between control board & panel.
	2. Defective board component	2. Check components U6, U7, U8, & related discretes.
I. No remote alarm function	1. Defective wiring	1. Check wiring between control board & remote alarm terminal block.
	2. Defective board component	2. Check relay CR1 for operation. Check related components Q7, U6, U7, & related discretes. component.

III. All major failure modes are represented above. In cases where the particular fault is not listed, component level diagnostics must be performed. This may be accomplished using the parts list (page.89),component layout, and schematic (Figure 25).

PARTS LIST - REVCO CONTROL BOARD - P/N C63652 - H15

SCHEMATIC REFERENCE	TOTAL QUANTITY	VALUE/DESCRIPTION	MODEL/TYPE AVAILABILITY
Resistors (0.5%,10 ppm		watt, metal film or wire wound)	
R10	1	100 ohm	Any Manufacturer
Resistors (1%, 25 ppm,		watt, metal film)	
R6, R7	2	4.42k ohm	Any Manufacturer
R8, R9	2	20k ohm	Any Manufacturer
R17	1	38.3k ohm	Any Manufacturer
R16	1	75k ohm	Any Manufacturer
R12, R13	2	536K ohm	Any Manufacturer
RESISTORS (1%, 50 ppm,		watt, metal film)	
R5	1	18.2 ohm	Any Manufacturer
R1	1	6.19k ohm	Any Manufacturer
R18	1	121k ohm	Any Manufacturer
R19	1	475 ohm	Any Manufacturer
R11	1	56.2 ohm	Any Manufacturer
RESISTORS (1%, 100 ppm,		watt, metal film)	
R22	1	909 ohm	Any Manufacturer
R42	1	221k ohm	Any Manufacturer
R25	1	267k ohm	Any Manufacturer
RESISTORS (5%,		watt, carbon film)	
R34, R54	2	43 ohm	Any Manufacturer
R52	1	100 ohm	Any Manufacturer
R39, R47, R49	3	390 ohm	Any Manufacturer
R14	1	470 ohm	Any Manufacturer
R20, R63, R70	3	1k ohm	Any Manufacturer
R15	1	1.2k ohm	Any Manufacturer
R26, R29, R30,R33 R43, R44, R45,R46	10	12k ohm	Any Manufacturer
R51, R53	2	18k ohm	Any Manufacturer
R50, R72	1	100k ohm	Any Manufacturer
R23	5	120k ohm	Any Manufacturer
R2,R3,R4,R21,R32	1	270k ohm	Any Manufacturer
R27	2	1 meg ohm	Any Manufacturer
R24, R31	1	22k ohm	Any Manufacturer
R69	1	36k ohm	Any Manufacturer
R68			
RESISTOR SIP PACK (2%, 1/8 watt)			
RP1	1	390 ohm x 4 (8 pin)	Any Manufacturer

PARTS LIST - REVCO CONTROL BOARD - P/N C63652-H15

SCHEMATIC REFERENCE	TOTAL QUANTITY	VALUE/DESCRIPTION	MODEL/TYPE AVAILABILITY
CAPACITORS (5%, 200 ppm, 50 VDC, molded polyester film)			
C12, C17, C13, C15 C16, C19, C23, C26	8	0.1 microfarad	Panasonic ECQ-VIH103J2 or equivalent
CAPACITORS (5%, 50 VDC, polyester film)			
C18	1	0.01 microfarad	ECQ-VIH103J2
C20	1	0.22 microfarad	ECQ-VIH224J2
C6	1	.47 microfarad	ECQ-VIH474J2
CAPACITORS (50V, 5%, NPO)			
C7, C14	2	100 pico farad	Sprague 1C10C0G101J05B (No Sub)
CAPACITORS (50v, Temp. Coef. X7R, monolithic ceramic)			
C4, C5, C8, C9 C24, C25, C27, C29, C37, C33, C35, C55, C39, C40, C42, C43, C45, C48, C49, C50, C52, C53, C54 C21, C47	25	0.1 microfarad	Sprague 1C10X7R104K050B
CAPACITORS (10%, Sprague 150D sealed tantalum or eq.) Axial			
C1, C2, C3	3	3.3 microfarad,15VDC	150D335X9015A2 or equivalent
CAPACITORS (LOW-LEAKAGE, RADIAL LEAD, ALUMINUM ELECTROLYTIC +/-20%)			
C10, C11	2	10 microfarad,16VDC	Panasonic Z series (ECE-A1610), or Nichicon KB series, or equivalent
CAPACITORS (radial lead, aluminum electrolytic +/-20%)			
C22, C28	2	47 microfarad,25VDC	SRE 47-25 Surge
C36, C38	2	100 microfarad,16VDC	SRE 1W-16 or equiv.
C30	1	330 microfarad,25VDC	SRE 330-25 or equiv.
C34	1	470 microfarad,25VDC	SRE 470-25 or equiv.
INDUCTORS (20% tolerance, epoxy radial lead)			
L1	1	10 microhenry, less than 2 ohms CD resistance, 250 ma max. current	Mouser 43LR105

PARTS LIST - REVCO CONTROL BOARD - P/N C63652-H15

SCHEMATIC REFERENCE	TOTAL QUANTITY	VALUE/DESCRIPTION	MODEL/TYPE AVAILAVILITY
FUSE HOLDERS			
F1, F2, F3	6	Fuse Clips	Bussman 1A3399-12 or equivalent
FUSES (GMA)			
F1, F2	2	1 ampere,slo-blo,GMA 250V	Any Manufacturer
F3	1	0.5 ampere,normal blo GMA 250V	Any Manufacturer
DIODES			
D1, D3, D4, D5 D7, D16	6	1N4148, Switching Type	Any Manufacturer
D6, D8	2	1N4004, 1 amp, 400VDC	Any Manufacturer
D13, D15	2	1N5393, 1.5 amp,200VDC	Any Manufacturer
D2	1	LM385BZ-2.5, 2.5 volt reference, TO-92 case	National Semi.
D9	1	W04M Diode Bridge	Any Manufacturer
TRANSISTORS			
Q3, Q4, Q5, Q6, Q7	5	PN2222A, NPN, TO-92	Any Manufacturer
INTEGRATED CIRCUITS			
U1, U2	2	LM324	Any Manufacturer
U3	1	4016 or 14016	Any Manufacturer
U4	1	4017 or 14017	Any Manufacturer
U5	1	74LS38	Any Manufacturer
U6	1	14572UB	Any Manufacturer
U7	1	4043 or 14043B	Any Manufacturer
U8	1	4071 or 14071	Any Manufacturer
U9, U10	2	4060 or 14060B	Any Manufacturer
U11	1	7662	Any Manufacturer
U12	1	7107	Harris or Equivalent
U14	1	LM340T5,5VDC Reg., TO-220	Any Manufacturer
U15	1	MC78L05ACZ5 VDC Reg., TO-92	Any Manufacturer
DISPLAYS			
D18, D19	2	Red 7-segment display .04 in. char. ht., MAN4710A	General Instrument or equivalent
D17	1	Red "1" and polarity sign, .4 in. char. ht., MAN4705A	General Instrument or equivalent

PARTS LIST - REVCO CONTROL BOARD - P/N C63652-H15

SCHEMATIC REFERENCE	TOTAL QUANTITY	VALUE/DESCRIPTION	MODEL/TYPE AVAILABILITY
RELAYS			
CR1, CR2	2	DPDT, 12 VDC coil 2 amp, sealed	OMRON, G2VN-234-US, 12 VDC
SURGE PROTECTORS			
M1, M4, M3	3	30 vac operating	Panasonic ERZ-C05DK470
M2	1	10 vac operating	Panasonic ERZ-C05DK180
POTENTIOMETERS			
R65	1	1k ohm, 50 ppm, 10% tol., top adjust	VRN 780-10A
R64	1	200 ohm, 50 ppm, 10% tol., top adjust	VRN 780-10A
R67	1	20k ohm, 50 ppm, 5% tol., top adjust	VRN 780-10A
R66	1	1m ohm, 50 ppm, 10% tol., top adjust	VRN 780-10A
CONNECTORS			
	1	12 pin	Buchanan SSB4W-12
	1	18 pin	Buchanan SSB4W-18
HEAT SINKS			
IC14	1	Vertical mount, for TO-220 AAVID case style, with tabs to solder into PCB, thermal coefficient 10 C rise pr watt (for 4 watt diss.) use grase, insulator not needed.	60130-015BP
SOCKETS			
D17, D18, D19	3	14-pin DIP-low profile	Any Manufacturer
U12	1	40-pin DIP	Any Manufacturer
JUMPERS			
LV, MS, J404, R73	4	Standard zero hom resistor	Any Manufacturer
PRINTED CIRCUIT BOARD			
404J		PCB shall be double sided plated-through holes, solder mask both sides, component labels silkscreened on component side. PCB edge fingers shall be gold plated. PCB shall be conformally coated after assembly but before final powered-up test. DO NOT coat heat sinks or LED displays.	

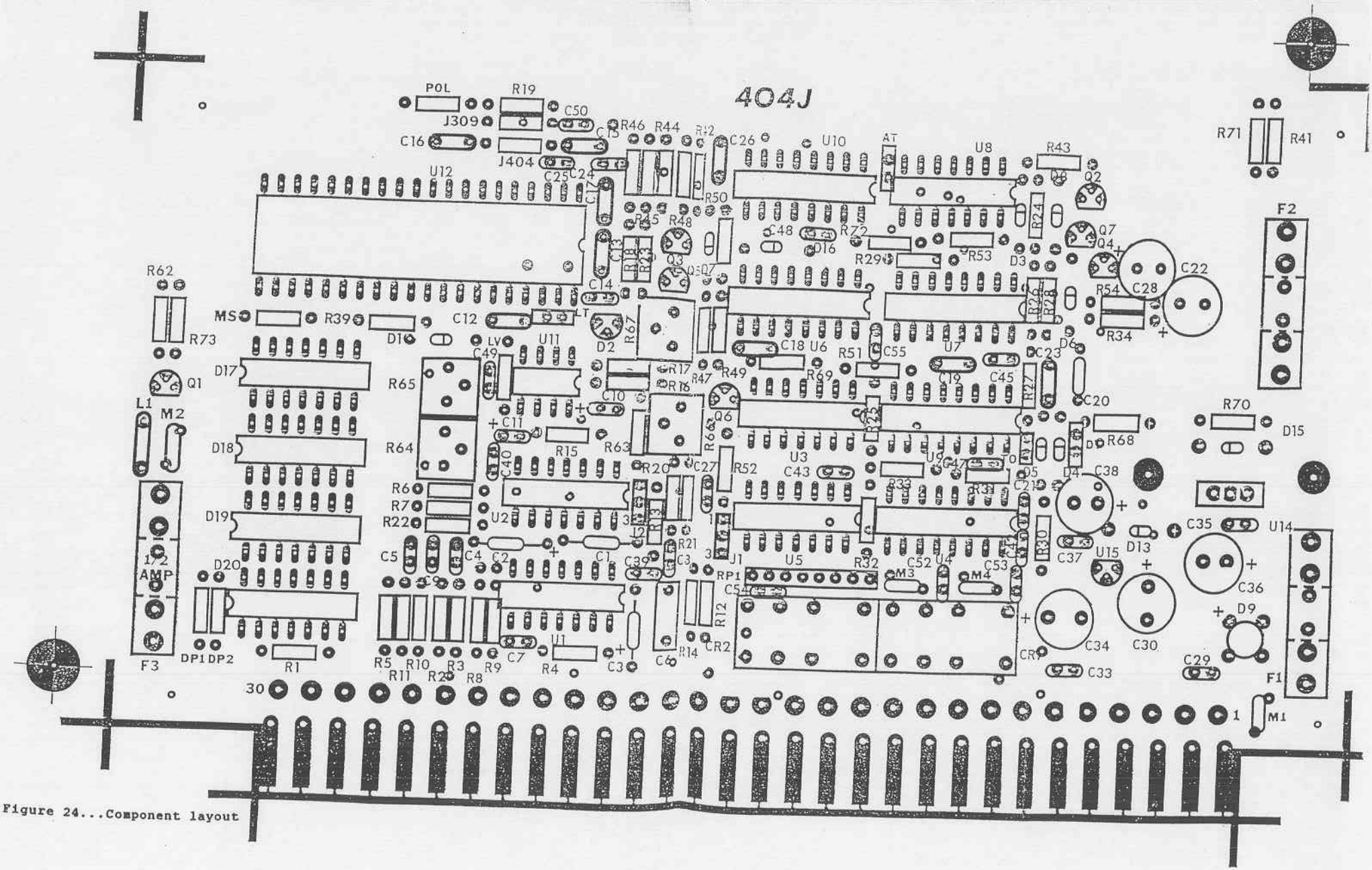


Figure 24...Component layout

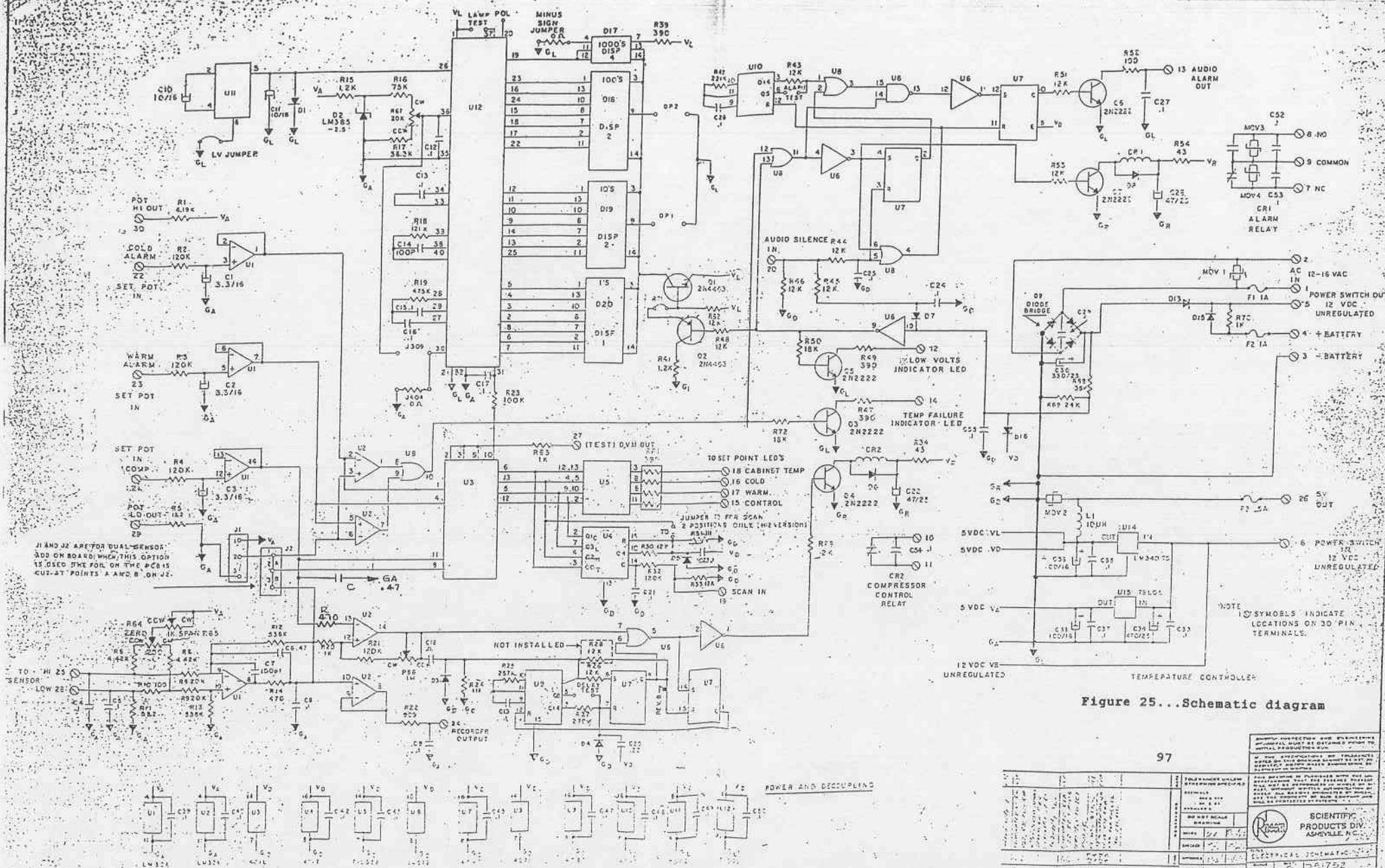

VL LAMP TEST
MINUS SIGN JUMPER
LV JUMPER
POT HI OUT
COLD ALARM SET POT IN
WARM ALARM SET POT IN
SET POT IN COMP
POT LO OUT
J1 AND J2 ARE FOR DUAL SENSOR ADD ON BOARD WHEN THIS OPTION IS USED TAKE FOIL ON THE PC BD IS CUT AT POINTS A AND B ON J2.
TO HI 23 SENSOR LOW 22
RECORDER OUTPUT
NOT INSTALLED
(TEST) O.V.H. OUT
TO SET POINT LED'S
18 CABINET TEMP
16 COLD
17 WARM
15 CONTROL
JUMPER TO PER SCAN 2 POSITIONS ONLY (HI VERSION)
SCAN IN
CR2 COMPRESSOR CONTROL RELAY
AUDIO SILENCE IN.
LOW VOLTS INDICATOR LED
TEMP FAILURE INDICATOR LED
13 AUDIO ALARM OUT
CR1 ALARM RELAY
8 NO
9 COMMON
7 NC
AC IN 12-16 VAC
POWER SWITCH OUT 12 VDC UNREGULATED
+ BATTERY
- BATTERY
5V OUT
POWER SWITCH IN 12 VDC UNREGULATED
5VDC VL
5VDC VD
5 VDC VA
12 VDC VB UNREGULATED
TEMPERATURE CONTROLLER
NOTE 1 SYMBOLS INDICATE LOCATIONS ON 30 PIN TERMINALS.
POWER AND DECOUPLING

Figure 25...Schematic diagram

SCIENTIFIC PRODUCTS DIV. ASHEVILLE, N.C.

ELECTRICAL SCHEMATIC

D81752

APPENDIX A

Table of Tables

Table#	Description	Page#
I	Temperature conversion	96 & 97

Table I...Temperature conversion

The number in degrees, either Fahrenheit or Celsius, in the center column, refer to temperature. If converting Fahrenheit to Celsius, the equivalent temperature will be in the left column. If converting Celsius to Fahrenheit, the equivalent temperature will be in the right column.

DEGREES C	DEG	DEGREES F	DEGREES C	DEG	DEGREES F	DEGREES C	DEG	DEGREES F
-101.1	-150	-238.0	-40.0	-40	-40.0	-17.8	0	32.0
-98.3	-145	-229.0	-39.4	-39	-38.2	-17.2	1	33.8
-95.6	-140	-220.0	-38.9	-38	-36.4	-16.7	2	35.6
-92.8	-135	-211.0	-38.3	-37	-34.6	-16.1	3	37.4
-90.0	-130	-202.0	-37.8	-36	-32.8	-15.6	4	39.2
-87.2	-125	-193.0	-37.2	-35	-31.0	-15.0	5	41.0
-84.4	-120	-184.0	-36.7	-34	-29.2	-14.4	6	42.8
-81.7	-115	-175.0	-36.1	-33	-27.4	-13.9	7	44.6
-78.9	-110	-166.0	-35.6	-32	-25.6	-13.3	8	46.4
-76.1	-105	-157.0	-35.0	-31	-23.8	-12.8	9	48.2
-73.3	-100	-148.0	-34.4	-30	-22.0	-12.2	10	50.0
-72.2	-98	-144.4	-33.9	-29	-20.2	-11.7	11	51.8
-71.1	-96	-140.8	-33.3	-28	-18.4	-11.1	12	53.6
-70.0	-94	-137.2	-32.8	-27	-16.6	-10.6	13	55.4
-68.9	-92	-133.6	-32.2	-26	-14.8	-10.0	14	57.2
-67.8	-90	-130.0	-31.7	-25	-13.0	-9.4	15	59.0
-66.7	-88	-126.4	-31.1	-24	-11.2	-8.9	16	60.8
-65.6	-86	-122.8	-30.6	-23	-9.4	-8.3	17	62.6
-64.4	-84	-119.2	-30.0	-22	-7.6	-7.8	18	64.4
-63.3	-82	-115.6	-29.4	-21	-5.8	-7.2	19	66.2
-62.2	-80	-112.0	-28.9	-20	-4.0	-6.7	20	68.0
-61.1	-78	-108.4	-28.3	-19	-2.2	-6.1	21	69.8
-60.0	-76	-104.8	-27.8	-18	-0.4	-5.6	22	71.6
-58.9	-74	-101.2	-27.2	-17	1.4	-5.0	23	73.4
-57.8	-72	-97.6	-26.7	-16	3.2	-4.4	24	75.2
-56.7	-70	-94.0	-26.1	-15	5.0	-3.9	25	77.0
-55.6	-68	-90.4	-25.6	-14	6.8	-3.3	26	78.8
-54.4	-66	-86.8	-25.0	-13	8.6	-2.8	27	80.6
-53.3	-64	-83.2	-24.4	-12	10.4	-2.2	28	82.4
-52.2	-62	-79.6	-23.9	-11	12.2	-1.7	29	84.2
-51.1	-60	-76.0	-23.3	-10	14.0	-1.1	30	86.0
-50.0	-58	-72.4	-22.8	-9	15.8	-0.6	31	87.8
-48.9	-56	-68.8	-22.2	-8	17.6	0.0	32	89.6
-47.8	-54	-65.2	-21.7	-7	19.4	0.6	33	91.4
-46.7	-52	-61.6	-21.1	-6	21.2	1.1	34	93.2
-45.6	-50	-58.0	-20.6	-5	23.0	1.7	35	95.0
-44.4	-48	-54.4	-20.0	-4	24.8	2.2	36	96.8
-43.3	-46	-50.8	-19.4	-3	26.6	2.8	37	98.6
-42.2	-44	-47.2	-18.9	-2	28.4	3.3	38	100.4
-41.1	-42	-43.6	-18.3	-1	30.2	3.9	39	102.2

Table I...Temperature conversion

FAHRENHEIT - CELSIUS TEMPERATURE CONVERSION CHART

The number in degrees, either Fahrenheit or Celsius, in the center column, refer to temperature. If converting Fahrenheit to Celsius, the equivalent temperature will be in the left column. If converting Celsius to Fahrenheit, the equivalent temperature will be in the right column.

DEGREES C	DEG	DEGREES F	DEGREES C	DEG	DEGREES F	DEGREES C	DEG	DEGREES F
4.4	40	104.0	26.7	80	176.0	48.9	120	248.0
5.0	41	105.8	27.2	81	177.8	51.7	125	257.0
5.6	42	107.6	27.8	82	179.6	54.4	130	266.0
6.1	43	109.4	28.3	83	181.4	57.2	135	275.0
6.7	44	111.2	28.9	84	183.2	60.0	140	284.0
7.2	45	113.0	29.4	85	185.0	62.8	145	293.0
7.8	46	114.8	30.0	86	186.8	65.6	150	302.0
8.3	47	116.6	30.6	87	188.6	68.3	155	311.0
8.9	48	118.4	31.1	88	190.4	71.1	160	320.0
9.4	49	120.2	31.7	89	192.2	73.9	165	329.0
10.0	50	122.0	32.2	90	194.0	76.7	170	338.0
10.6	51	123.8	32.8	91	195.8	79.4	175	347.0
11.1	52	125.6	33.3	92	197.6	82.2	180	356.0
11.7	53	127.4	33.9	93	199.4	85.0	185	365.0
12.2	54	129.2	34.4	94	201.2	87.8	190	374.0
12.8	55	131.0	35.0	95	203.0	90.6	195	383.0
13.3	56	132.8	35.6	96	204.8	93.3	200	392.0
13.9	57	134.6	36.1	97	206.6	96.1	205	401.0
14.4	58	136.4	36.7	98	208.4	98.9	210	410.0
15.0	59	138.2	37.2	99	210.2	101.7	215	419.0
15.6	60	140.0	37.8	100	212.0	104.4	220	428.0
16.1	61	141.8	38.3	101	213.8	107.2	225	437.0
16.7	62	143.6	38.9	102	215.6	110.0	230	446.0
17.2	63	145.4	39.4	103	217.4	112.8	235	455.0
17.8	64	147.2	40.0	104	219.2	115.6	240	464.0
18.3	65	149.0	40.6	105	221.0	118.3	245	473.0
18.9	66	150.8	41.1	106	222.8	121.1	250	482.0
19.4	67	152.6	41.7	107	224.6	123.9	255	491.0
20.0	68	154.4	42.2	108	226.4	126.7	260	500.0
20.6	69	156.2	42.8	109	228.2	129.4	265	509.0
21.1	70	158.0	43.3	110	230.0	132.2	270	518.0
21.7	71	159.8	43.9	111	231.8	135.0	275	527.0
22.2	72	161.6	44.4	112	233.6	137.8	280	536.0
22.8	73	163.4	45.0	113	235.4	140.6	285	545.0
23.3	74	165.2	45.6	114	237.2	143.3	290	554.0
23.9	75	167.0	46.1	115	239.0	146.1	295	563.0
24.4	76	168.8	46.7	116	240.8	148.9	300	572.0
25.0	77	170.6	47.2	117	242.6	151.7	305	581.0
25.6	78	172.4	47.8	118	244.4	154.4	310	590.0
26.1	79	174.2	48.3	119	246.2	157.2	315	599.0

ITEM	DESCRIPTION	PART #
7	VALVE SAFETY RELIEF	S47607H01
7A	VALVE SOLENOID	B45463H03
9	BATTERY	B45475H01
2	VALVE, SOLENOID	B44814H01
5	CHARGER, BATTERY	A46736H01
6	CONTROL	B45829H01
68	SWITCH, PUSH BUTTON	S63648H01
69	RESISTOR, 15 OHM 12 W	N85432H01
73	DC VOLTMETER	N85353H01

ITEM	DESCRIPTION	PART #
35	FUSE	A46731H01
88	TRANSFORMER	S41026H61
89	TRANSFORMER	S41026H62
95	SWITCH, ROCKER	A64151H03
92	FLANGED INLET 250V	S23401H01
54	RUPTURE DISK	A47438H01
91	FLANGED INLET 115V	A23400H01
70	STRAINER	S85359H01

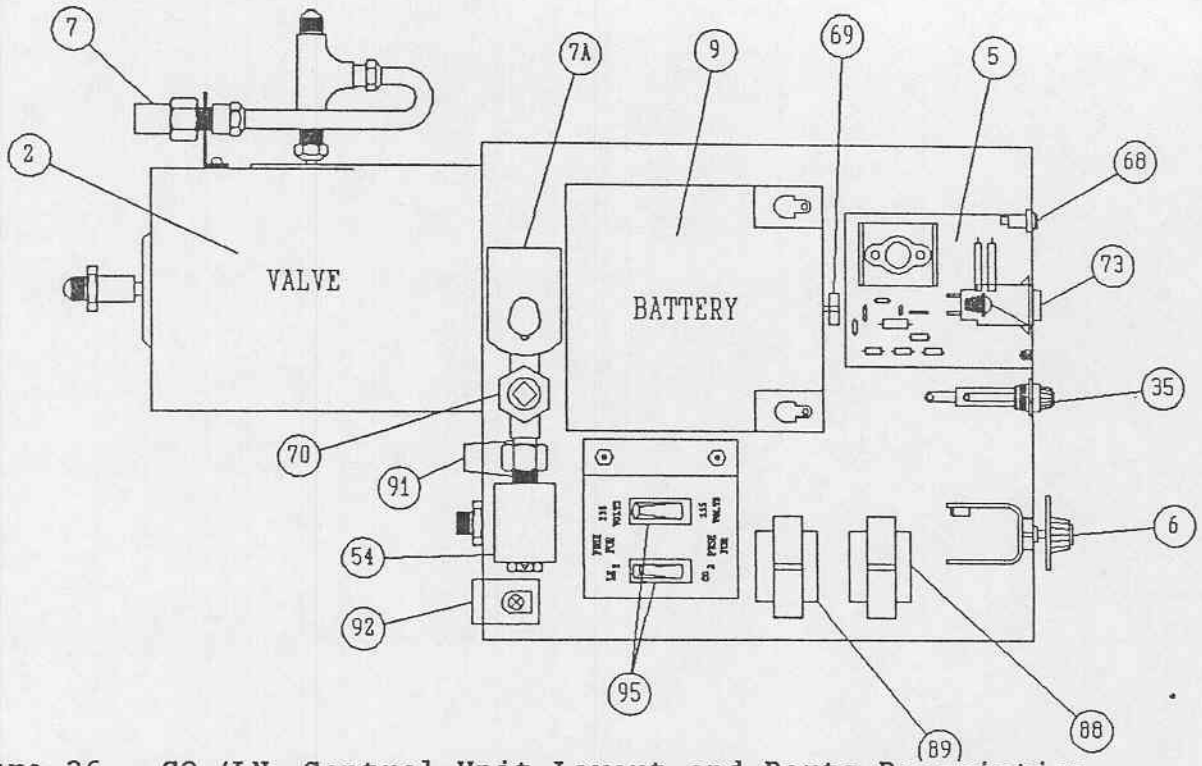


Figure 26...CO_2/LN_2 Control Unit Layout and Parts Description